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NATIONAL DAM INSPECTION PROGRAM. KNIGHT DAM. (NDS I.D. NUMBER 0--ETC(U)
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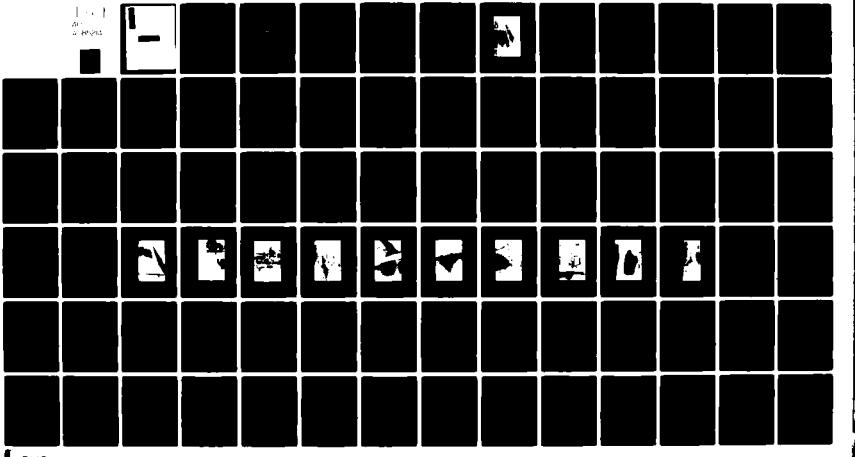

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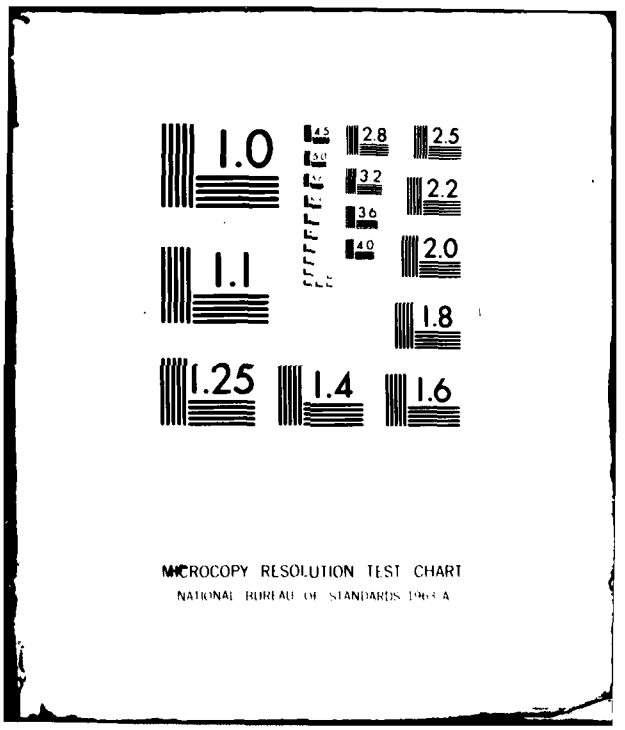
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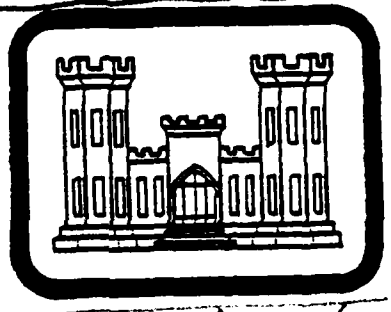
(1)

DELAWARE RIVER BASIN,
PERKIOMEN CREEK, Montgomery County,
(6) National Dam Inspection Program.
KNIGHT DAM, [redacted] PENNSYLVANIA.
(NDS I.D. NO. 00395,
DER I.D. NO. 46-257)
Number

PHASE I INSPECTION REPORT,
[redacted]

(10) Mary F. Beck
John H. Frederick, Jr.



(15) DACW31-80-C-0018

Prepared by:

WOODWARD-CLYDE CONSULTANTS
5120 Butler Pike
Plymouth Meeting, Pennsylvania 19462

Submitted to:

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

(12) 86

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394157

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I Investigations. Copies of these guidelines may be obtained from the Office of the Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to expeditiously identify those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, testing and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify the need for more detailed studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected, and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam:	Knight Dam
County Located:	Montgomery County
State Located:	Pennsylvania
Stream:	Perkiomen Creek
Coordinates:	Latitude 40° 20.0'
	Longitude 75° 28.9'
Date of Inspection:	November 19, 1979

Knight Dam is owned by the Montgomery County Commissioners and maintained by the Parks Department. Visual inspection of the exposed sections of the dam and review of the limited available data indicate that Knight Dam is in good condition. It is noted that the entire spillway and apron were submerged and could not be inspected. Therefore, a complete visual assessment of the structure could not be made. The dam is classified as a "Small" size structure with a "High" hazard classification consistent with its potential in the event of sudden failure for extensive property and loss of life downstream along Perkiomen Creek.

In accordance with criteria established by Federal (OCE) Guidelines, the spillway design flood for this "Small" size dam and "High" hazard classification is 0.5 to the full Probable Maximum Flood (PMF). As the total storage capacity is nearer the lower limit for the "Small" size classification and as the weir can be expected to be submerged during the PMF, the selected spillway design flood is 0.5 PMF.

Hydrologic and hydraulic calculations indicate that the spillway structure is capable of discharging about 0.47 PMF without overtopping the spillway walls. As 0.5 PMF is not judged to cause failure of the dam by overtopping, the spillway rating for this structure is considered to be "Inadequate" but not "Seriously Inadequate".

It is recommended that the following items of routine maintenance and surveillance be undertaken as soon as practical.

(1) The apron area along the downstream toe of the spillway should be periodically inspected, especially after periods of high flows to check for scour or deterioration of the downstream toe.

(2) The trees growing against the left spillway wall should be removed.

(3) The joint filler at the expansion joints in the spillway walls should be replaced.

(4) The erosion noted at the downstream end of the left spillway wall is not significant at this time but should be monitored.

Because of the location of the dam and the potential for heavy property damage and possible loss of life in the event of failure, a formal procedure of observation and warning during periods of high precipitation should be developed and implemented. This procedure should include a method of warning downstream residents along Perkiomen Creek that high flows are expected and provisions for evacuating these people in the event of an emergency. An operation and maintenance procedure should also be developed to insure that all pertinent items are carefully inspected on a regular basis and maintained in the best possible condition.

Mary F. Beck 4/30/80

Mary F. Beck, P.E. Date
Pennsylvania Registration 27477E
Woodward-Clyde Consultants

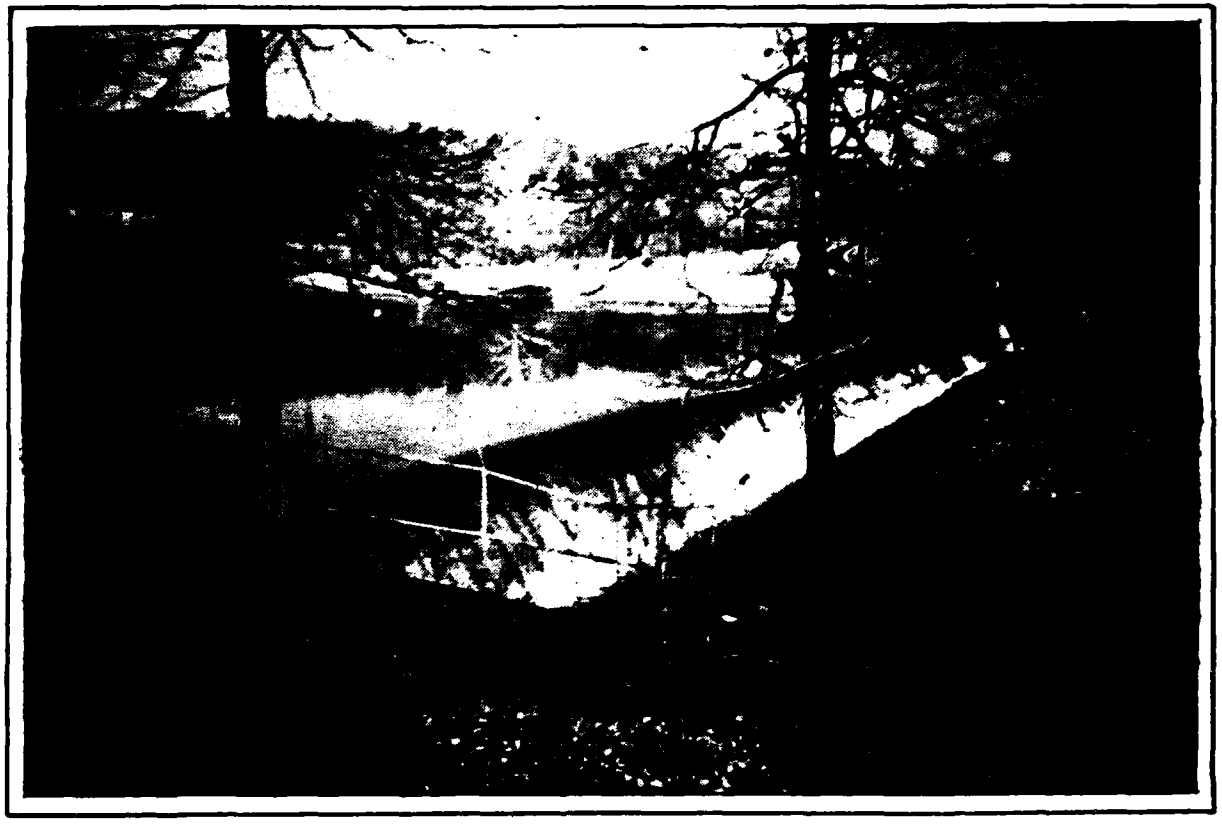
4/30/80

John H. Frederick, Jr., P.E. Date
Maryland Registration 7301
Woodward-Clyde Consultants

APPROVED BY:

21 MAY 80

JAMES W. PECK Date
Colonel, Corps of Engineers
District Engineer



OVERVIEW
KNIGHT DAM, MONTGOMERY COUNTY, PENNSYLVANIA

TABLE OF CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
KNIGHT DAM
NATIONAL ID NO. PA 00395
DER NO. 46-257

SECTION 1
PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Knight Dam is a concrete gravity run-of-the-river dam with an ogee weir about 15 feet above the existing streambed. The 415 foot long, 22 foot high dam impounds a reservoir of about 170 acre-feet at normal pool. The upstream face of the dam is vertical. A 155 foot long concrete retaining wall at the left end of the dam, with a top elevation of 220, prevents water from flowing over Pennsylvania Route 29. An 83 foot long retaining wall is at the right end with the same top elevation. Construction documentation indicates the weir section is founded on rock.

Outlet works are located at the right end of the dam, as shown in Photograph 3, and consist of two conduits which are gated at the upstream end and reported to be 24 inches in diameter. The gate hoists are operated from a platform above the conduits, access to which is through a locked gate.

b. Location. The dam is located across the Perkiomen Creek, about 3,000 feet southwest of the center of Green Lane Borough. The dam is in Upper Frederick and Marlborough Townships, Montgomery County, Pennsylvania. The dam site and reservoir are located on the USGS Quadrangle map entitled "Perkiomenville, Pennsylvania", at coordinates N 40° 20.0' W 75° 28.9'. A regional location plan of Knight Dam and reservoir is enclosed as Plate 1, Appendix E.

c. Size Classification. The dam is classified as a "Small" size dam by virtue of its estimated total capacity of 479 acre-feet and 22 foot height.

d. Hazard Classification. A "High" hazard classification is assigned consistent with the dam's location above an urban area and the potential to cause extensive property damage and possible loss of life downstream along the creek.

e. Ownership. The dam is owned by the Montgomery County Commissioners. All correspondence should be addressed to Mr. A. Russell Parkhouse, Chairman, Montgomery County Commissioners, Court House, Norristown, Pennsylvania 19401.

f. Purpose of Dam. The dam serves to prevent flooding of the adjacent highway, Pennsylvania Route 29, and the reservoir is used for recreational purposes.

g. Design and Construction History. The original dam at the site, Knickerbocker Dam, was one of three dams built around 1888 by the American Ice Company of Philadelphia. The rockfill timber crib structure was about 12 feet high and 250 feet long. During the flood of 1902, all dams were breached, increasing the water level at Brey Dam, 3,500 feet downstream, by three feet. The dam, or what remained of it, was at the site when construction of the present Knight Dam began.

Drawings for Knight Dam were prepared by the office of the Montgomery County Engineer in 1957 and 1958. The original plans were for a longer dam with the outlet works near the center, rather than at the right abutment. Except for a drawing which shows the dates when portions of the concrete weir and retaining walls were cast, there are no drawings in the state files which show the as-built configuration of the dam with the outlet works at the right abutment. Construction records indicate that concrete for the weir and retaining walls was cast between February 8 and September 1, 1960, when one section of spillway was remaining to be cast. No other design and construction history was available in Department of Environmental Resources files.

h. Normal Operating Procedures. Reservoir flows are normally discharged over the weir.

1.3 Pertinent Data.

A summary of pertinent data for Knight Dam is presented as follows.

a.	Drainage Area (square miles)	94.5
b.	Discharge at Dam Site (cfs)	
	Maximum Known Flood at Dam Site (June 1972)	11,400[1]
	At Top of Dam	30,500
c.	Elevation (feet above MSL)	
	Top of Dam	220.0
	Spillway Weir	213.0
	Pond Drain Inlet	201±
	Pond Drain Outlet	201±
	Tailwater (November 19, 1979)	201.8
	Stream Bed at Downstream Toe	197.6
d.	Reservoir (feet)	
	Length at Normal Pool (est)	3,500
	Length at Maximum Pool (est)	5,000
	Fetch at Normal Pool	1,300
e.	Estimated Storage (acre-feet)	
	To Spillway	170
	To Top of Dam	479
f.	Reservoir Surface Area (acres)	
	Normal Pool	34
g.	Dam Data	
	Type	Concrete gravity
	Length	415 feet
	Maximum Height	22 feet
	Volume	5,900 cubic yards
	Side Slopes	
	Upstream	Vertical
	Downstream	Ogee weir
	Cutoff	None known
	Grout Curtain	None
h.	Spillway	
	Type	Ogee weir
	Elevations (feet)	
	Weir	213.0
	Downstream Apron	197.6
i.	Outlet Works	
	Type	Two 24 inch conduits gated at upstream end
	Reservoir Drain Inlet	201±
	Conduit Outlet Invert	201±

(1) Reported maximum discharge at upstream Green Lane Dam.

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Data Available. The data available for review from Department of Environmental Resources (DER) files were limited to design drawings for a somewhat different dam at the site (with the outlet works at the center of the dam and a footbridge crossing the dam), test boring logs and a concrete placement record sheet. The only engineering analysis available for this dam is a stability analysis for the weir section. The Montgomery County Engineer's Office provided the drawing enclosed as Plate 4, Appendix E.

b. Design Features. The principal design features of Knight Dam are illustrated on the plan and cross-section enclosed as Plates 2 and 3, Appendix E. Data for these plates were obtained from DER files.

2.2 Construction.

Beyond the limited information given in Section 1.2, there are no data available concerning the construction history of this dam and reservoir.

2.3 Operational Data.

There are no operational records maintained. There are no known minimum flow requirements downstream of this dam.

2.4 Evaluation.

a. Availability. Information presented herein was obtained from records located in DER files in Harrisburg, Pennsylvania, and the Montgomery County Engineer's Office and from conversations with the Owner's representative.

b. Adequacy. The available data included in the state files are not adequate to evaluate the engineering aspects of the dam and appurtenant structures.

c. Validity. There is no reason to question the validity of the limited available data.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. Observations and comments of the field inspection team are contained in the checklist enclosed herein as Appendix A, and are summarized and evaluated in the following subsections. In general, the appearance of the facility in November 1979, indicates that the dam is in good condition. At the time of the inspection, the creek was flowing at a normal rate over the spillway and, thus, the ogee section and downstream apron could not be inspected. A plan and cross-section of the dam are shown in Plates 2 and 3, Appendix E.

b. Dam. The vertical alignment of the dam was checked, and the profile is shown on sheet 5B, Appendix A. No discernible horizontal or vertical displacement was noted along the crest. Water was flowing uniformly over the entire length of the dam. The junction to the right abutment appears in good condition. The minimum elevation of backfill behind the right spillway wall is equal to the top of the spillway wall. The wall itself is in good condition, with no cracking noted, although some joint filler is missing from expansion joints in the wall. Drains through the wall were rust stained. The left spillway wall also appears in good condition. The left spillway wall, shown in Photograph 6, is not backfilled to the top at its downstream end. The wall extends 105 feet upstream into natural ground. Two small trees are growing adjacent to the wall on the reservoir side near the upstream end. These should be removed. On the highway side of the wall near the downstream end are two minor depressions. At the downstream end of the wall is erosion resulting from surface runoff or foot traffic. Large stone is at the downstream end of the wall. The depressions and erosion are not considered significant at this time but should be monitored. The exposed portion of the wall has fine vertical cracks extending two to three feet below the top of the wall, spaced uniformly between construction joints. Some of the vertical cracks are connected at the bottom by a horizontal crack. This cracking is assessed to be temperature cracking and not structural cracking. Joint filler is completely missing from construction joints in the wall and should be replaced.

Outlet works consist of two conduits, reported to be 24 inches in diameter, through the dam at the right end, as shown in Photograph 2. Both conduits are gated at their

upstream end, and gate hoists are located on the platform above them, shown in Photograph 3. The platform appears to be in good condition. Both gates were operated smoothly and appeared to seat completely. Unauthorized access is prevented by a locked gate through a cyclone and barbed wire fence on the top of the right retaining wall.

c. Reservoir. The reservoir slopes are flat to moderate and vegetated to the water's edge with grass or trees. Knight Dam was built immediately downstream of the confluence of Deep Creek with Perkiomen Creek. Immediately above this confluence on Deep Creek is Deep Creek Dam. Knight Dam reservoir extends up to the toe of Deep Creek Dam, which is shown on Photograph 10. About 3,000 feet due north of Knight Dam on Perkiomen Creek is Green Lane Dam. This 87 foot high dam is shown on Photograph 9. No sedimentation was noted at the upper end of the reservoir, and very little debris was noted.

d. Downstream Channel. The downstream channel is the Perkiomen Creek, as shown in Photograph 4. The stream narrows from the 400 foot width at the dam to about 100 feet under the first highway bridge, about 300 feet downstream. Below the first highway bridge, the channel is about 100 feet wide and up to six feet deep. There is a small run-of-the-river dam about 1,000 feet below Knight Dam, which is about five feet high and 120 feet long. Brey Dam, eight feet high and about 3,500 feet below Knight Dam, is immediately downstream of the first major damage center. Upstream of Brey Dam is an old mill building, shown in Photograph 8, which still has a mill race diverting flow from the Perkiomen Creek into the building. Water flows through the mill building and under Route 29 before entering a channel and being carried back into the Perkiomen Creek. There is at least one apartment on its upper floors. Upstream of the mill building are seven homes, some of which are shown in Photograph 7. Three of the houses appear to be less than six feet above the creek bank. All along the Perkiomen Creek to its confluence with the Schuylkill River are scattered houses and businesses built in the floodplain.

3.2 Evaluation.

Inspection of the dam, outlet works and retaining walls disclosed no evidence of apparent past or present movement that would indicate existing instability of the dam, spillway walls or outlet structure. The dam crest appears to be uniform and water flows smoothly over it. Since flow was passing over the spillway at the time of the inspection, the

toe of the spillway could not be inspected for undermining, scour or the condition of the apron section. All exposed structural features of the dam were observed to be in good condition.

The only items to be noted are of a routine maintenance nature, and they are the replacement of joint filler material in both the left and right spillway walls and removal of trees adjacent to the left spillway wall. The erosion noted at the downstream end of the left spillway wall requires only monitoring at this time.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures.

Operation of the dam does not require a dam tender. Under normal conditions, the pond drain gates are closed, and water discharges over the dam.

4.2 Maintenance of the Dam.

Upper Perkiomen Valley Park employees provide routine maintenance for the dam.

4.3 Maintenance of Operating Facilities.

Park employees provide routine maintenance to the operating facilities. The pond drain sluice gate is operated in the spring.

4.4 Warning Systems In Effect.

There is no written warning system in effect for this dam.

4.5 Evaluation.

It is judged that the current operating procedure, which does not require a dam tender, is a realistic means of operating the relatively simple control facilities of Knight Dam. It is noted that formal operational, maintenance and warning procedures should be developed and implemented. Maintenance procedures should include an inspection checklist which would include a listing of items to be checked during each inspection and repaired as necessary to insure proper performance of the structure.

SECTION 5
HYDROLOGY/HYDRAULICS

5.1 Evaluation of Features.

a. Design Data. There is no original design data nor subsequent hydrologic/hydraulic evaluation data available for this dam. The stability analysis indicates a "full head" elevation on the weir to be 219. The watershed is composed of three major subwatersheds. About 600 feet west of Knight Dam is Deep Creek Dam and watershed, which has a total drainage area of 5.62 square miles. The Deep Creek Watershed is approximately 70 percent wooded and 30 percent residential development. About 1.1 river miles upstream of Knight Dam is Green Lane Dam, with a drainage area of 71 square miles. Green Lane Dam is 87 feet high and 780 feet long, and the top of the dam impounds a maximum pool of over 25,000 acre-feet. About 0.6 river mile upstream of Knight Dam is the confluence of Perkiomen Creek and Macoby Creek. Macoby Creek has a drainage area of about 18 square miles. There are no dams located within that sub-watershed. Elevations within the entire 94.5 square mile Knight Dam drainage area range from about 1,100 in the upper reaches to 213, the elevation of Knight Dam.

In accordance with criteria established by Federal (OCE) Guidelines, the spillway design flood for this "Small" size dam and "High" hazard classification is one-half to the full Probable Maximum Flood (PMF). As the total storage capacity is nearer the lower limit for the "Small" size classification and as the weir can be expected to be submerged during the PMF, the selected spillway design flood is the 0.5 PMF.

b. Experience Data. There are no records of reservoir levels kept for this dam, and there is no estimate of the maximum depth of water over the dam. It is reported that the maximum discharge of the upstream Green Lane Dam was 11,400 cfs in June 1972, during Tropical Storm Agnes.

c. Visual Observations. On the date of the inspection, there were no conditions observed that would indicate a reduction in spillway capacity during an extreme event. Observations regarding the condition of the downstream channel, spillway and reservoir are located in Appendix A and are discussed in greater detail in Section 3.

d. Overtopping Potential. The overtopping potential of this dam was estimated using the HEC-1, Dam Safety Version, computer program. A brief description of the program is included in Appendix D.

Calculations for this investigation estimate a spillway discharge of about 30,500 cfs when the reservoir level is at the elevation of the spillway walls. The HEC-1 program computed the peak 0.5 PMF inflow to be about 32,614 cfs, and the program estimates the spillway walls would be overtopped by 0.3 foot during the 0.5 PMF. The spillway is capable of passing about 0.47 PMF without overtopping the walls. Failure of upstream Deep Creek Dam was considered and is expected not to increase the peak discharge from Knight Dam.

e. Spillway Adequacy. A spillway that will not pass the 0.5 PMF without overtopping the dam is rated as "Seriously Inadequate", provided two other conditions are present. One is failure of the dam by overtopping. The dam is judged not to fail during the 0.5 PMF, and therefore, the spillway is rated as "Inadequate" but not "Seriously Inadequate".

f. Downstream Conditions. The first damage center is about 1,800 feet below the dam where a house is built in the floodplain. A major downstream damage center is approximately 3,100 feet below the dam, above the intersection of Route 29 and Perkiomenville Road, as shown on Plate 1. At that point, three of the seven (all of which are not shown on Plate 1) houses are less than six feet above the bank of the Perkiomen Creek. The structure closest to Brey Dam, shown on Plate 1, is an old mill. Water is still diverted from Perkiomen Creek through the building. All along the Perkiomen Creek to its confluence with the Schuylkill River are scattered homes and businesses built in the floodplain.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. Visual observations detected no evidence of existing or impending instability of the structure. All exposed items of the structure were inspected and found to be in good condition. There was no distortion along the spillway crest to infer excessive scour downstream, monolithic displacement or structural deterioration of the ogee section. However, the entire ogee section was covered with water and could not be thoroughly inspected. The nonoverflow sections of the dam were found to be in good condition.

b. Design and Construction Data. Known design and construction documentation is described in Section 1.2. Included as part of the drawings dated 1957 and 1958 for a proposed dam at the site is a stability analysis of the weir section. The design analysis indicated that the spillway stability is adequate. The spillway which was constructed, as shown on Plate 3, extends ten feet deeper than the original design. Based on the original analysis, it is assessed that the stability of the as-built weir is also adequate.

c. Operating Records. There are no operational records for this structure.

d. Post-Construction Changes. There is no evidence to suggest that modifications were made to this dam since it was completed in 1960.

e. Seismic Stability. The dam is located in Seismic Zone 1. Normally it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected earthquake conditions. As the dam is qualitatively assessed to be stable under present static loading conditions, it can reasonably be assumed to be stable under seismic loading conditions.

SECTION 7
ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Evaluation. Visual inspection of the exposed sections of the dam and review of the very limited available data indicate that Knight Dam is in good condition. It is noted that the entire spillway and apron were submerged and could not be inspected. Therefore, a complete assessment of the structure could not be performed. In accordance with criteria established by Federal (OCE) Guidelines, the spillway design flood for this "Small" size dam and "High" hazard classification is one-half to the full Probable Maximum Flood (PMF). As the total storage capacity is nearer the lower limit for the "Small" size classification and as the weir can be expected to be submerged during the PMF, the selected spillway design flood is one-half the PMF. Calculations presented in Appendix D indicate that the spillway is capable of discharging about 0.47 PMF without overtopping the spillway walls. As the 0.5 PMF is not judged to cause failure, the spillway rating for this structure is considered to be "Inadequate" but not "Seriously Inadequate".

b. Adequacy of Information. Information available for this investigation was sufficient to evaluate the dam and appurtenant structures in accordance with Phase I Inspection criteria. However, an insufficient portion of the structure was exposed to perform a complete visual inspection.

c. Urgency. The recommendations presented in Section 7.2 should be implemented as specified.

7.2 Remedial Measures.

a. Facilities. It is recommended that the following items of routine maintenance and surveillance be undertaken as soon as practical.

(1) The apron area along the downstream toe of the spillway should be periodically inspected, especially after periods of high flows to check for scour or deterioration of the downstream toe.

(2) The trees growing against the left spillway wall should be removed.

(3) The joint filler at the expansion joints in the spillway walls should be replaced.

(4) The erosion noted at the downstream end of the left spillway wall is not significant at this time but should be monitored.

b. Operation and Maintenance Procedures. Because of the location of the dam and the potential for heavy property damage and possible loss of life in the event of failure, a formal procedure of observation and warning during periods of high precipitation should be developed and implemented. This procedure should include a method of warning downstream residents along Perkiomen Creek that high flows are expected and provisions for evacuating these people in the event of an emergency. An operation and maintenance procedure should also be developed to insure that all pertinent items are carefully inspected on a regular basis and maintained in the best possible condition.

APPENDIX

A

CHECK LIST
VISUAL INSPECTION
PHASE I

Name Dam *Knight Dam* County *Montgomery* State *Pennsylvania* National ID # *PA 00395*

Type of Dam *Concrete* Hazard Category *High*

Date(s) Inspection *11/19/1979* Weather *Sunny* Temperature *60's*

Pool Elevation at Time of Inspection *213.2* M.S.L. Tailwater at Time of Inspection *201.8* M.S.L.

Inspection Personnel:

Mary F. Beck (Hydrologist)
Arthur H. Dvinoff (Geotechnical/Civil)
Raymond S. Lambert (Geologist)
Vincent McKeever (Hydrologsit) (9/13/1979)
John H. Frederick (4/9/1980)

Mary F. Beck Recorder

Remarks:

Mr. Otto Quinque, Upper Perkiomen Valley Superintendent and park employees were on site and provided assistance to the inspection team.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	*None observed, the entire downstream toe is under water.*	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	*Junction to right abutment appears in good condition. Junction to left abutment appears in good condition with the exception of erosion at the end of the downstream wall caused by surface runoff and/or foot traffic.*	
DRAINS	*Drains through downstream right spillway wall were wet with rust stains.*	
WATER PASSAGES	*N/A*	
FOUNDATION	*Reportedly on firm bedrock.*	

CONCRETE/MASONRY DAMS

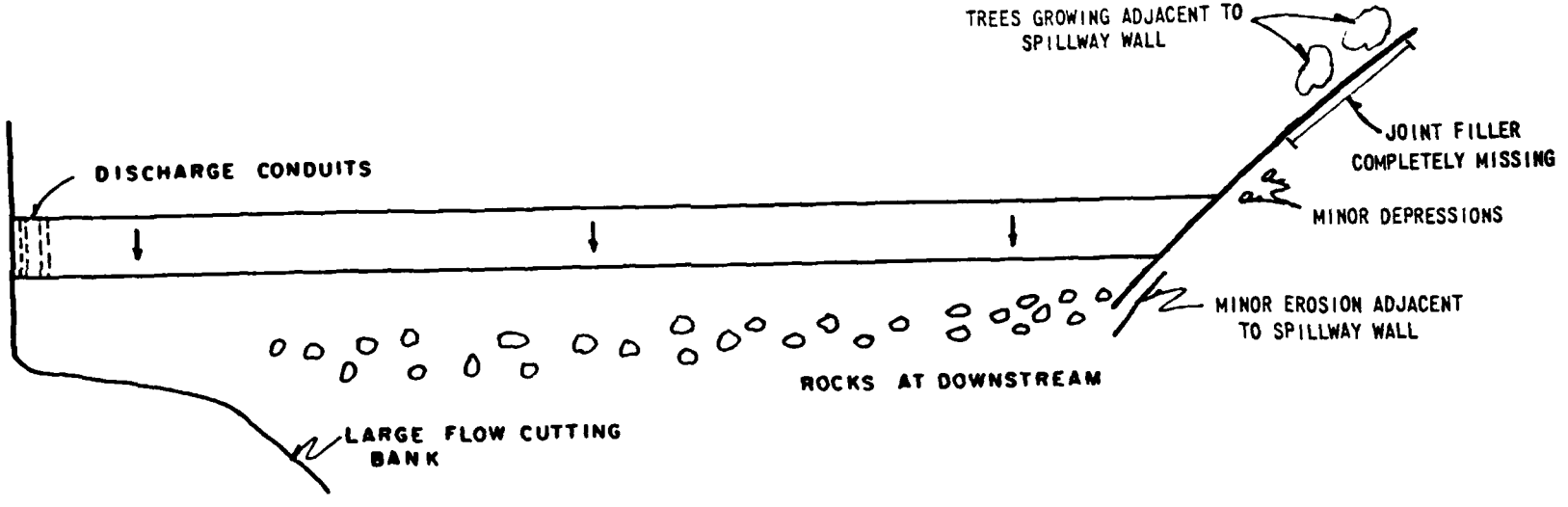
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	*No cracking was observed on the right spillway wall which is backfilled to the top of the wall. The left spillway wall which is not backfilled has fine vertical cracks extending 2 to 3 feet below the top of the wall spaced uniformly between expansion joints. Some of the vertical cracks are connected at the bottom by a horizontal crack.*	
STRUCTURAL CRACKING	*None observed.*	
VERTICAL AND HORIZONTAL ALIGNMENT	*Both the vertical and horizontal alignment appear to be good.*	
MONOLITH JOINTS	*None observed, water flowing over weir.*	
CONSTRUCTION JOINTS	*The joint filler is completly missing from expansion joints in the left spillway wall and partially missing from expansion joints in the right spillway wall.*	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	*N/A*	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	*N/A*	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	*N/A*	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	*N/A*	
RIPRAP FAILURES	*N/A*	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	*N/A*	
ANY NOTICEABLE SEEPAGE	*N/A*	
STAFF GAGE AND RECORDER	*N/A*	
DRAINS	*N/A*	



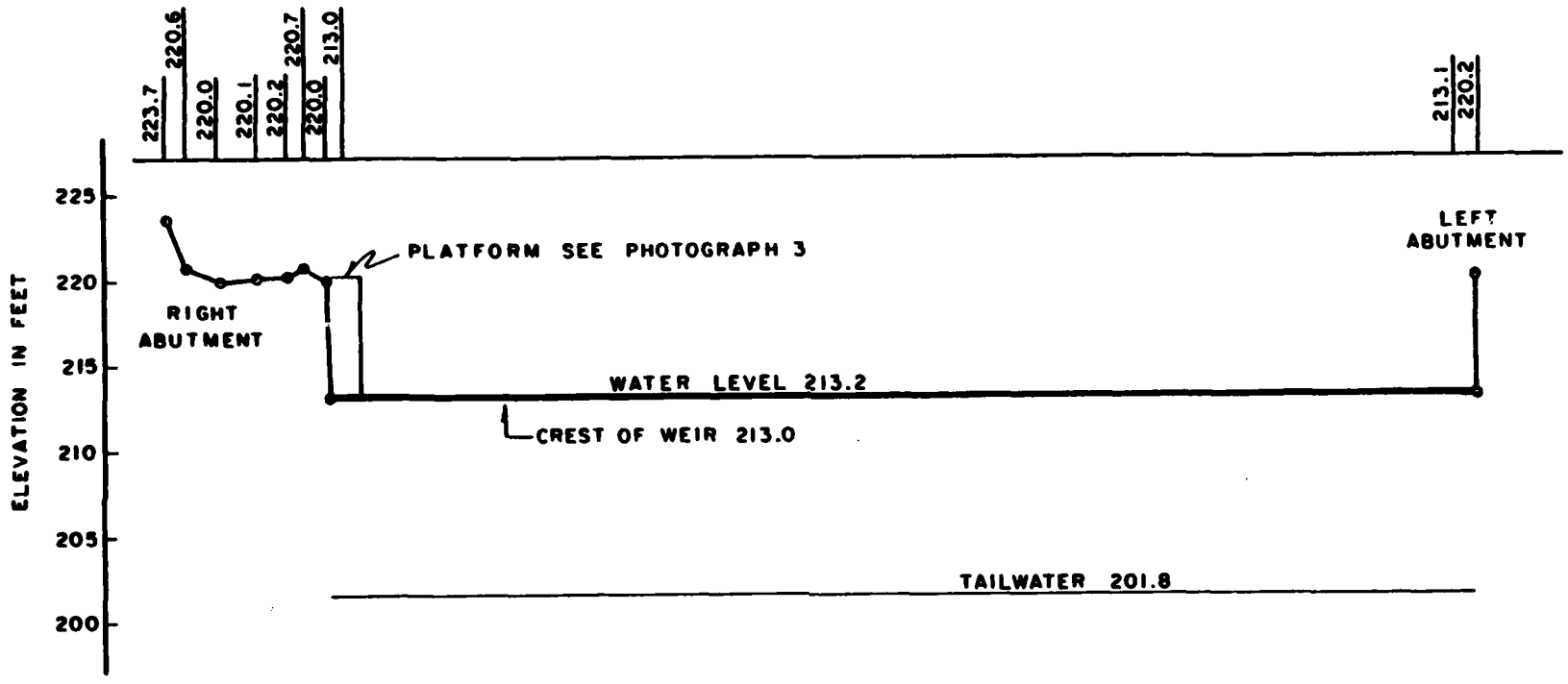
LOOKING UPSTREAM

SCALE IN FEET

0 30 60

FIELD OBSERVATION PLAN
KNIGHT DAM

SHEET 5A OF 11



LOOKING UPSTREAM

SCALE IN FEET

0 30 60

FIELD OBSERVATION PROFILE
KNIGHT DAM

SHEET 5B OF 11

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	*Conduits through dam are located under the right end of the ogee weir. Reported dimensions are 24 inch diameter.*	
INTAKE STRUCTURE	*Appears in good condition.*	
OUTLET STRUCTURE	*None, the pipes outlet at the toe of the weir, see Photograph No. 2. Appendix D.*	
OUTLET CHANNEL	*Discharge is directly into channel below weir.*	
EMERGENCY GATE	*Both gates operated smoothly and appear to seat completly.*	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	*At the time of inspection, water was flowing over the crest uniformly.*	
APPROACH CHANNEL	*N/A*	
DISCHARGE CHANNEL	*The channel narrows to about 100 feet wide below the dam.*	
BRIDGE AND PIERS	*None*	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	*N/A*	
APPROACH CHANNEL	*N/A*	
DISCHARGE CHANNEL	*N/A*	
BRIDGE AND PIERS	*N/A*	
GATES AND OPERATION EQUIPMENT	*N/A*	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	*None*	
OBSERVATION WELLS	*None*	
WEIRS	*None*	
PIEZOMETERS	*None*	
OTHER		

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	*The reservoir slopes are flat and well vegetated to the water's edge with grass and trees.*	
SEDIMENTATION	*Little sediment noted at upeer end, no effect on flood water storage. Little debris along reservoir's edge.*	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	*The 100 foot wide downstream channel appears in good condition. Immediately downstream of the dam where the channel narrows from 400 feet, there is some bank cutting which presents no problem. The stream bed contains many large boulders which have resulted from in place weathering of bedrock. About 1,000 feet downstream is a weir about 5 feet high built across the creek.*	
SLOPES	*The valley gradient is approximately 0.016.*	
APPROXIMATE NO. OF HOMES AND POPULATION	*About 0.7 mile below the dam are seven houses an an old mill with at least one apartment on its upper floors. Part of the flow from Perkiomen Creek still flows through the race under the mill building. The first floor of at least three of the houses appear to be less than 6 feet above the creek bank. All along Perkiomen Creek are homes built in the flood plain.*	

APPENDIX

B

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM *Knight Dam*

ID # *PA 00395*

ITEM	REMARKS
AS-BUILT DRAWINGS	*None available.*
REGIONAL VICINITY MAP	*See Plate 1, Appendix E.*
CONSTRUCTION HISTORY	*See text, Section 1.2*
TYPICAL SECTIONS OF DAM	*See Appendix E.*
OUTLETS - PLAN	*See Appendix E.*
DETAILS	
CONSTRAINTS	
DISCHARGE RATINGS	*See Appendix D.*
RAINFALL/RESERVOIR RECORDS	*None*

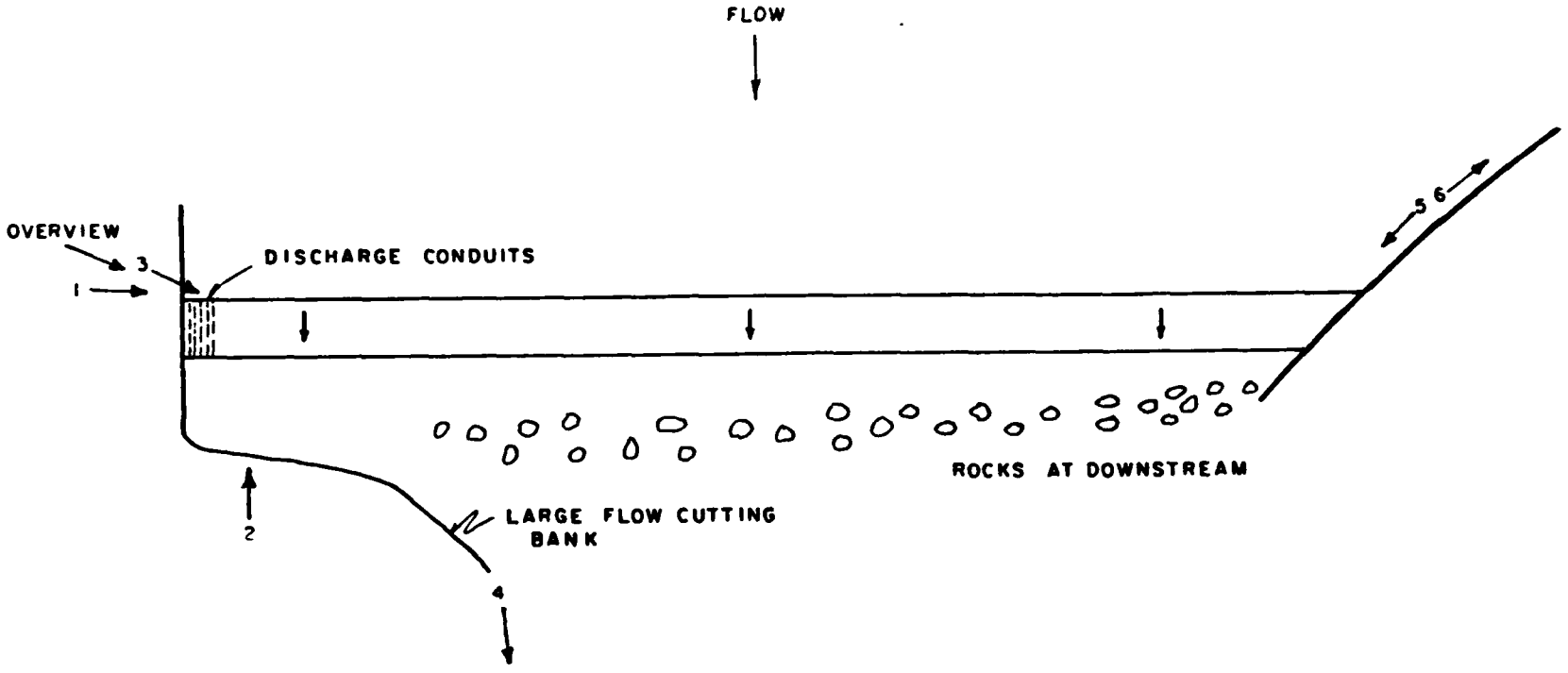
ITEM	REMARKS
DESIGN REPORTS	*None available.*
GEOLOGY REPORTS	*See Appendix F.*
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	*Only stability calculations available.*
MATERIALS INVESTIGATIONS	*Unknown*
BORING RECORDS	*See Appendix E.*
LABORATORY FIELD	*Unknown*
POST-CONSTRUCTION SURVEYS OF DAM	*None known.*
BORROW SOURCES	*N/A*

ITEM	REMARKS
MONITORING SYSTEMS	*None*
MODIFICATIONS	*None*
HIGH POOL RECORDS	*None*
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	*None*
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	*None*
MAINTENANCE OPERATION RECORDS	*None*

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	*See Appendix E.*
OPERATING EQUIPMENT PLANS & DETAILS	*None*

APPENDIX

C



PHOTOGRAPH LOCATION PLAN
KNIGHT DAM

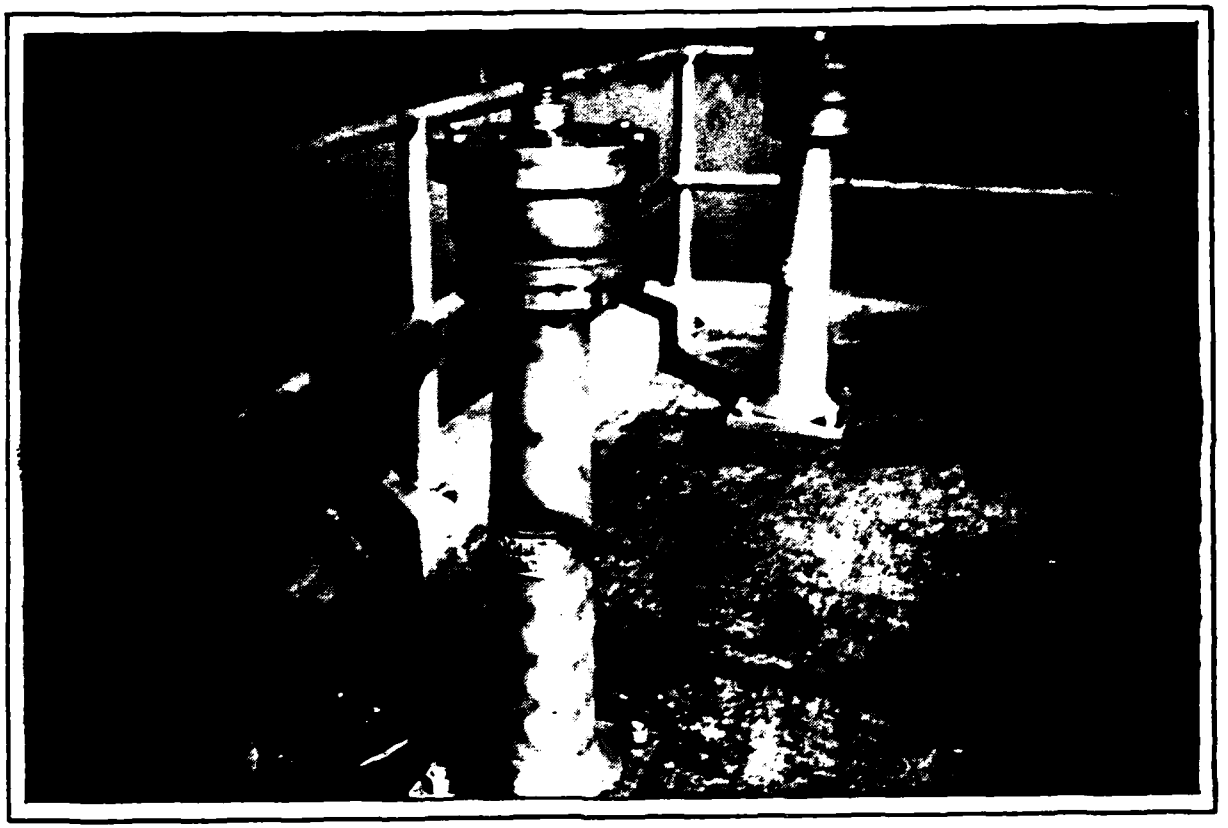
PLATE C-1

SPILLWAY CREST. NOTE FLOW IS UNIFORM OVER CREST.

PHOTOGRAPH NO. 1

OUTLET WORKS AT RIGHT END
OF WEIR.

PHOTOGRAPH NO. 2



GATE HOIST AND PLATFORM.

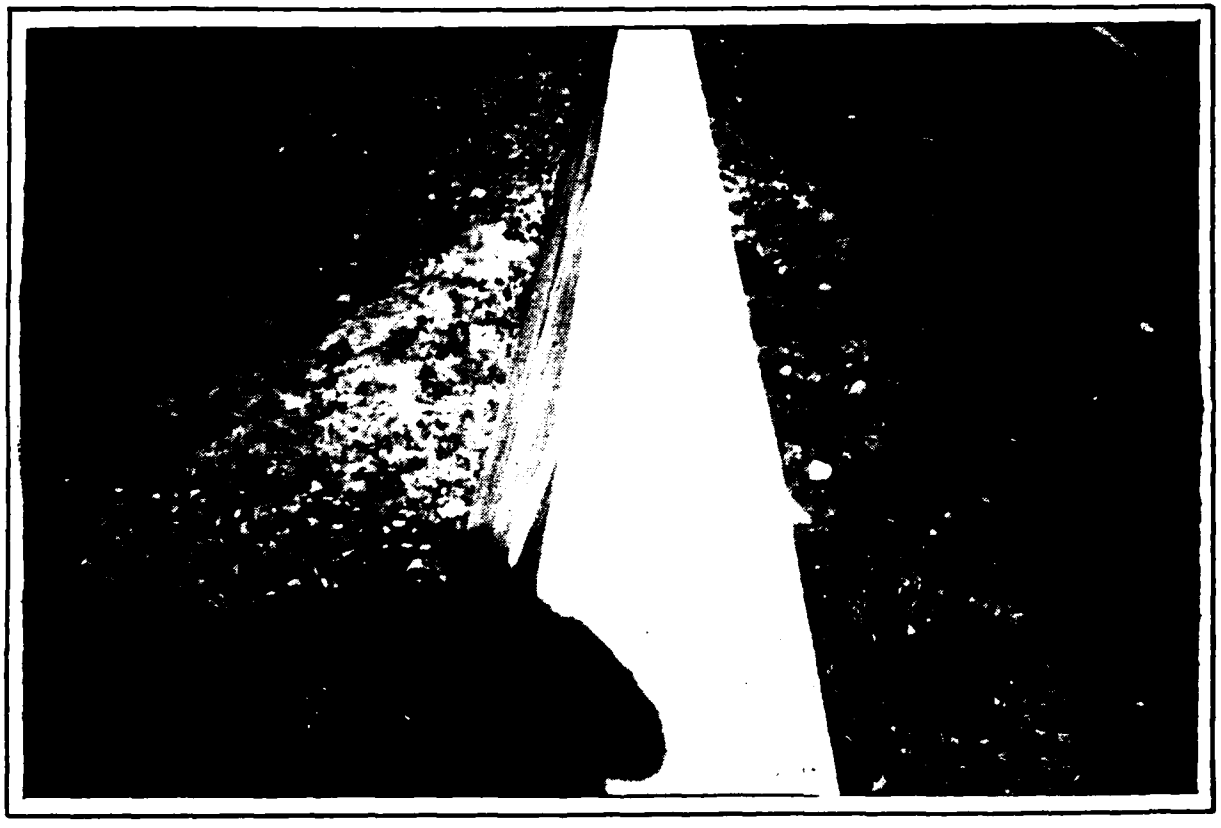
PHOTOGRAPH NO. 3

VIEW OF DOWNSTREAM CHANNEL AND
BRIDGE LOCATED ABOUT 300 FEET
BELOW DAM.

PHOTOGRAPH NO. 4

VIEW OF LEFT SPILLWAY WALL. WEIR TO RIGHT.

PHOTOGRAPH NO. 5

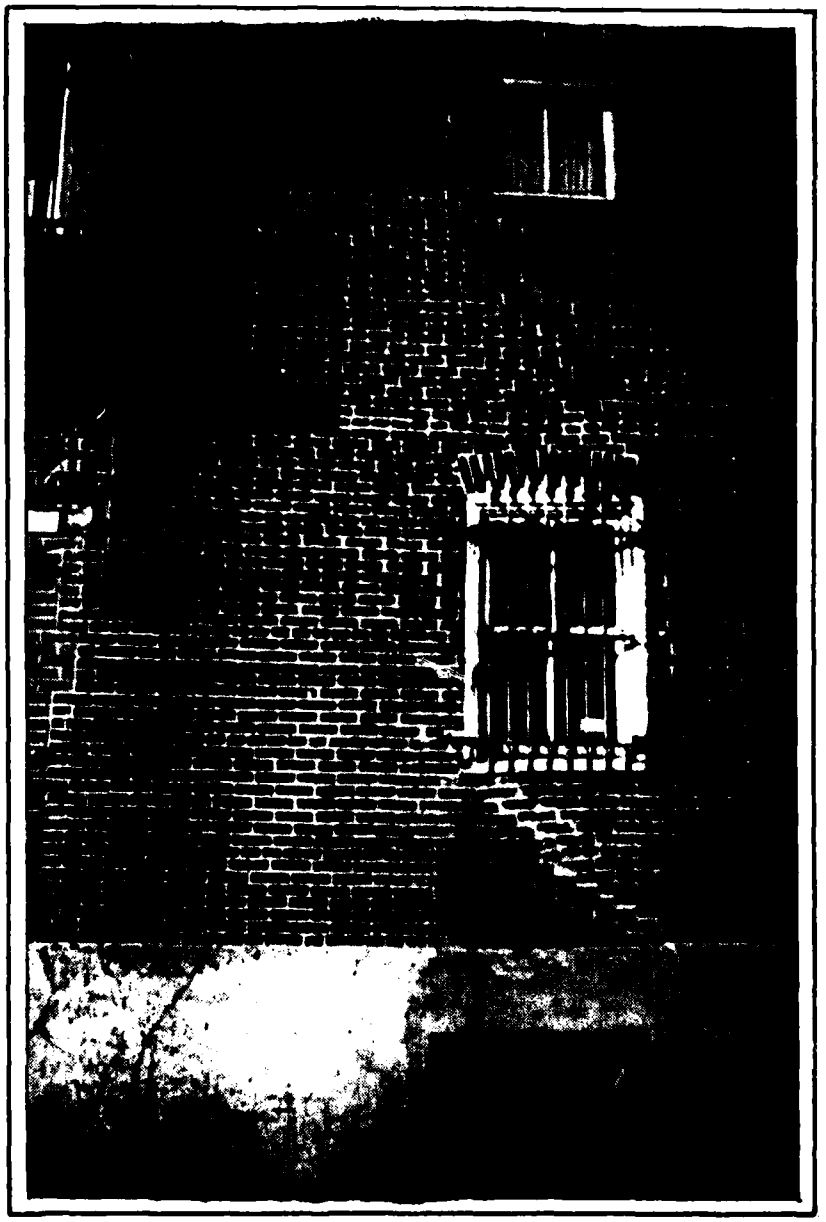


LEFT UPSTREAM SPILLWAY WALL.

PHOTOGRAPH NO. 6

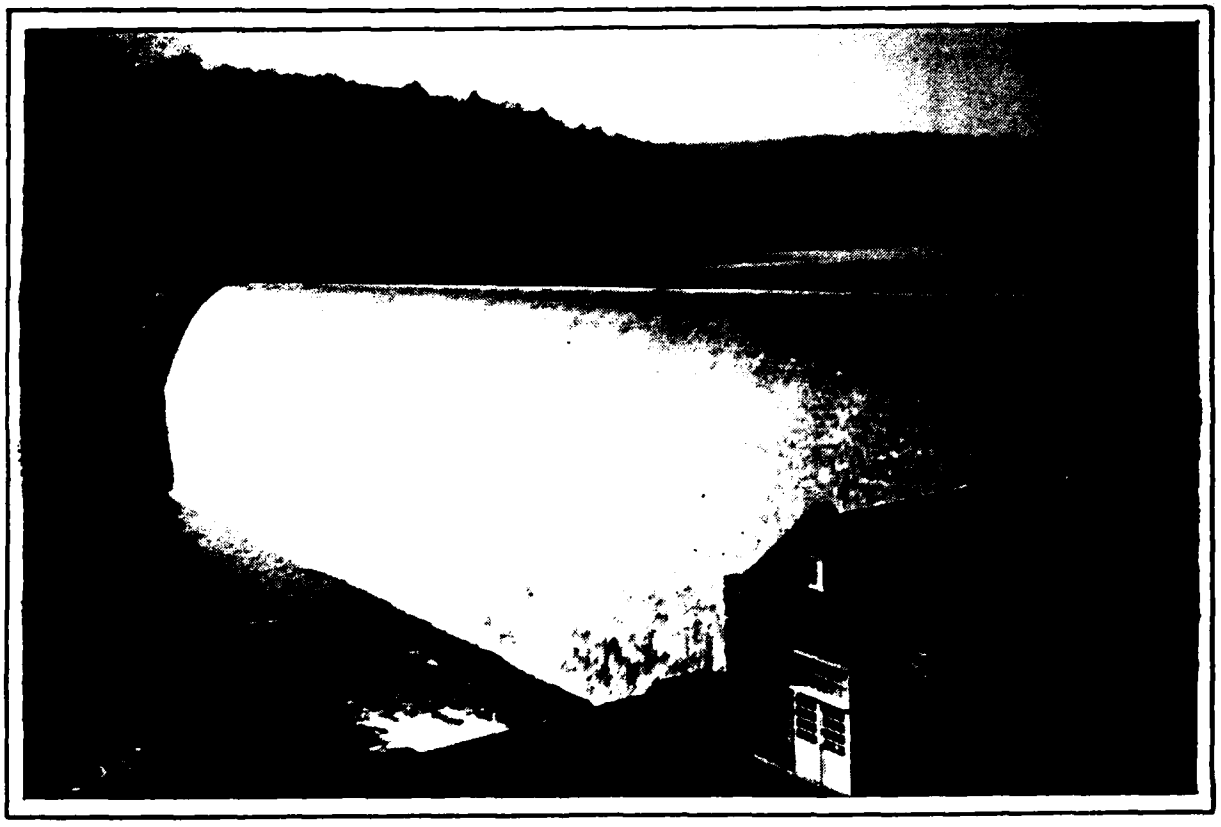
DOWNSTREAM DAMAGE CENTER LOCATED
ABOUT 0.7 MILE DOWNSTREAM.

PHOTOGRAPH NO. 7



SMALL PART OF PERKIOMEN CREEK FLOW IS DIVERTED THROUGH THE BASEMENT OF THIS BUILDING.

PHOTOGRAPH NO. 8



UPSTREAM GREEN LANE DAM.

PHOTOGRAPH NO. 9

UPSTREAM DEEP CREEK DAM.

PHOTOGRAPH NO. 10

APPENDIX

D

KNIGHT DAM
CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: *About 50% wooded, the rest is predominantly open/farm land, little residential development.*

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): *213.0 feet (170 Acre-Feet).*

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): *220.0 feet (479 Acre-Feet).*

ELEVATION MAXIMUM DESIGN POOL: *219.0 feet*

ELEVATION TOP DAM: *220.0 feet*

SPILLWAY

a. Elevation *213.0 feet.*

b. Type *Concrete ogee weir*

c. Width *413.5 feet*

d. Length ---

e. Location Spillover *Run-of-the-river.*

f. Number and Type of Gates *None*

OUTLET WORKS:

a. Type *2-24 inch conduits.*

b. Location *Right end.*

c. Entrance inverts *201± feet.*

d. Exit inverts *201± feet.*

e. Emergency draindown facilities *Outlet works.*

HYDROMETEOROLOGICAL GAGES:

a. Type *None maintained by Owner.*

b. Location *N/A*

c. Records *N/A*

MAXIMUM NON-DAMAGING DISCHARGE: *Not determined.*

DRAINAGE AREA:(1) *94.5 square miles total.*

PROBABLE MAXIMUM PRECIPITATION (PMP)
FOR 10 SQ. MILES IN 24 HOURS:(2) *23.0 inches.*

ADJUSTMENT FACTORS FOR DRAINAGE AREA (%):(3)

Zone *6*

6 Hours *90*

12 Hours *99*

24 Hours *109*

48 Hours *122*

SNYDER HYDROGRAPH PARAMETERS:(4)

Zone *

C_p, C_t *0.625, 2.0*	*Deep Creek (5.62 sq. mile)*	*Green Lane (71.0 sq. mile)*	*Macoby Creek (17.93)*
L(5)	*3.98*	*18.2*	*9.75*
Lca (6)	*2.08*	*10.4*	*4.64*
$tp=C_t\ (L\cdot Lca)^{0.3}$	*3.77*	*9.64*	*6.27*

SPILLWAY CAPACITY AT MAXIMUM
WATER LEVEL(7) *30449 cfs*

---

(1) Measured from USGS maps.
(2) Hydrometerological Report No. 33, Figure 1.
(3) Hydrometerological Report No. 33, Figure 2.
(4) Information received from Corps of Engineers, Baltimore District.
(5) Length of longest water course from outlet to basin divide, measured from USGS maps.
(6) Length of water course from outlet to point opposite the centroid of drainage area, (see Plate 1, Appendix E) measured from USGS maps.
(7) See Sheet *4,11* of this Appendix.

* *Parameter determined from analysis of flood records at downstream Gratersford gaging station on Perkiomen Creek. Calculations by Philadelphia Suburban Water Company are dated 1950-53 and were used in the design of upstream Green Lane Dam. In 1973, the original analysis was reviewed by Woodward-Clyde Consultants and judged adequate.*

HEC-1, REVISED FLOOD HYDROGRAPH PACKAGE

The original "Flood Hydrograph Package" (HEC-1), developed by the Hydrologic Engineering Center, Corps of Engineers, has been modified for use under the National Dam Inspection Program. The "Flood Hydrograph Package (HEC-1), Dam Safety Version", hereinafter referred to as, HEC-1, Rev., has been modified to require less detailed input and to include a dam breach analysis. The required input is obtained from the field inspection of a dam, any available design/evaluation data, relatively simple hydraulic calculations, or information from the USGS Quandrangle maps. The input format is flexible in order to reflect any unique characteristics of an individual dam.

HEC-1, Rev. computes a reservoir inflow hydrograph based on individual watershed characteristics such as: area, percentage of impervious surface area, watershed shape, and hydrograph characteristics determined from regional correlation studies by the Corps of Engineers, Baltimore District. The inflow is routed through the reservoir using spillway discharge data obtained from the field inspection or design data. Flood storage capacity is determined from USGS maps or design information and verified by the field inspection. In the event a spillway cannot discharge 0.5 PMF without overtopping and failure of the dam, downstream channel characteristics obtained from the field inspection and USGS maps are inputed and flows are routed downstream to the damage center and a dam breach analysis is performed.

Included in this Appendix are the HEC-1, Rev. pertinent input values and a summary print-out tables.

BY MEB DATE 4/14/80 SUBJECT Knight Dam SHEET 4 OF 11

CHKD. BY AHD DATE 4/15/80 Hydrology / Hydraulics JOB No.

Classification (Ref. Recommended Guidelines for Safety Inspection of Dams)

1. The hazard classification is rated as "High" as there would be economic loss and possible loss of life in the event of sudden failure.

2. The size classification is "Small" based on its total capacity of 479 Ac-Ft

3. The selected spillway design flood, based on size and hazard classification, is 0.5 PMF (Probable Maximum Flood).

Hydrology and Hydraulic Analysis

1. Original design data is limited to a stability analysis indicating the full head on the weir to be 219.0, i.e. the design head on the weir is 6.0 ft.

2. Evaluation Data

Inflow hydrograph parameters are shown on sheet 2.

Elevation - storage data. Surface areas for elevations 204 209 213 & 218 were measured from a topo plan dated Nov. 1957 (as received by DER). Surface area for elev. 220 was measured from current USGS map. Area above 220 was estimated.

Elevation - discharge data. Shape of ogee section conforms to design head, H_o, of 6.0 ft. The angle of the left spillway wall reduces the effective length of the weir. Assume $L = 410$ ft. $H_o = 6$ ft, $P = 11.5$ ft.

$P/H_o = 11.5/6 = 1.92$ $C_o = 3.93$ Design of Small Dams Bureau of Reclamation, 2nd. 1978

W.S.	H_e	H_e/H_o	C/C_o	C	L	$Q = C L H_e^{3/2}$
213	0	0			410	0
214	1	0.17	0.85	3.34		1369 ✓ cfs
215	2	0.33	0.89	3.50		4059 ✓
216	3	0.50	0.92	3.62		7712 ✓ Discharge
217	4	0.67	0.95	3.73		12234 ✓ assuming
218	5	0.83	0.98	3.85		17648 ✓ weir not
220	7	1.17	1.02	4.01		30449 ✓ submerged
222	9	1.50	1.06	4.17		46162 ✓
225	12	2.0	1.07	4.21		71753

Available for review was the preliminary HEC-2 (Water Surface Profiles) run of Perkiomen Creek prepared for the Federal Emergency Management Agency. Water surface elevations for a section 70 ft downstream of the dam are:

W.S.	Q
200 ft	0 channel invert
204.6	7,000 cfs
207.0	12,150
208.5	15,650
213.7	29,100 cfs

Although the weir is partly submerged during 0.5 PMF event, the maximum water level is not expected to be significantly higher. Maximum water elevation during the PMF will be significantly higher.

3. Spillway Adequacy -
A spillway is considered "Seriously Inadequate" only if overtopping by 0.5 PMF will cause failure. As the spillway walls are overtopped without failing by the 0.5 PMF, the spillway is considered "Inadequate."

4. Failure of Upstream Dams
Failure of only upstream Deep Creek Dam was considered. The peak discharge from Deep Creek Dam occurs over 5 hours before the peak discharge from Knight Dam. Thus, Knight Dam peak discharge is not increased, see sheet 11A.

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	GLIN	Green Lane
ROUTE HYDROGRAPH TO	GLU	
RUNOFF HYDROGRAPH AT	IN	Deep Creek
ROUTE HYDROGRAPH TO	OUT	
RUNOFF HYDROGRAPH AT	MCI	Macoby Creek
COMBINE 3 HYDROGRAPHS AT	KIN	Knight Dam
ROUTE HYDROGRAPH TO	KNOUT	
END OF NETWORK		

1**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****

RUN DATE= 80/04/15.
TIME= 05.46.52.

KNIGHT DAM
NAT ID NO. PA 935 DER NO. 46-257
OVERTOPPING ANALYSIS

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	1	0	0	0	0	0	0	-4	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 3 LRTIO= 1
RTIOS= .40 .50 1.00

SUB-AREA RUNOFF COMPUTATION

GREEN LANE INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
GLIN	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

INYDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISAME	LOCAL
1	1	71.00	0.00	95.00	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	23.00	90.00	99.00	109.00	122.00	0.00	0.00

IRSPC COMPUTED BY THE PROGRAM IS .846

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 9.64 CP= .63 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 53 END-OF-PERIOD ORDINATES, LAG= 9.66 HOURS, CP= .63 VOL= 1.00

97.	340.	727.	1149.	1604.	2070.	2481.	2785.	2975.	3049.
2970.	2731.	2439.	2170.	1945.	1737.	1551.	1385.	1237.	1105.
987.	881.	787.	703.	627.	560.	500.	447.	399.	356.
318.	284.	254.	227.	202.	181.	161.	144.	129.	115.
103.	92.	82.	73.	65.	58.	52.	47.	42.	37.
33.	30.	26.							

END-OF-PERIOD FLOW

0 NO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	NO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	24.29	21.79	2.51	1014421.
										(617.)(553.)(64.)(28725.20)			

HYDROGRAPH ROUTING

GREEN LANE OUTFLOW HYDROGRAPH

ISTAU	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
GLO	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-286.	-1

STAGE	286.00	287.00	288.00	289.00	290.00	291.00	292.00	293.00	294.00	295.00
	296.00	297.00	298.00	299.00						
FLOW	0.00	1272.00	3772.00	7404.00	11397.00	16496.00	22189.00	28583.00	35398.00	43273.00
	51402.00	60323.00	69622.00	79500.00						
CAPACITY=	34.	321.	1096.	2467.	4784.	9149.	13398.	16942.	28416.	
ELEVATION=	230.	240.	250.	260.	270.	280.	286.	290.	300.	

CREL	SPUID	COOU	EXPU	ELEVL	COOL	CAREA	EXPL
286.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
297.0	3.1	1.5	360.

PEAK OUTFLOW IS 20205. AT TIME 51.00 HOURS

PEAK OUTFLOW IS 25547. AT TIME 51.00 HOURS

PEAK OUTFLOW IS 52690. AT TIME 50.00 HOURS

Green Lane Dam and storage data obtained from Phase I Inspection Report

SUB-AREA RUNOFF COMPUTATION

DEEP CREEK INFLOW HYDROGRAPH

ISTAU	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
IN	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISMOM	ISAME	LOCAL
1	1	5.62	0.00	95.00	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	23.00	90.00	99.00	109.00	122.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .866

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 3.77 CP= .63 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 21 END-OF-PERIOD ORDINATES. LAG= 3.75 HOURS, CP= .63 VOL= 1.00

73. 261. 474. 596. 555. 426. 317. 236. 176. 131.
97. 72. 54. 40. 30. 22. 17. 12. 9. 7.
5.

END-OF-PERIOD FLOW

0 HO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	HO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	24.29	21.79	2.51	83934.
										(617.)(553.)(64.)(2376.75)			

HYDROGRAPH ROUTING

DEEP CREEK OUTFLOW HYDROGRAPH

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
OUT	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-225.	-1

STAGE	224.50	225.50	226.50	227.50	228.50	229.50	230.50	232.50
FLOW	0.00	287.00	860.00	1650.00	2622.00	3778.00	5065.00	8187.00
SURFACE AREA=	0.	5.	14.	25.	99.			
CAPACITY=	0.	10.	55.	141.	1039.			
ELEVATION=	210.	215.	220.	225.	240.			

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
224.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
229.0	0.0	0.0	0.

Deep Creek Dam data obtained from Phase I Inspection Report

CREST LENGTH AT OR BELOW ELEVATION	0. 228.0	85. 229.0	330. 229.5	640. 230.0

PEAK OUTFLOW IS 3484. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 4343. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 8714. AT TIME 41.00 HOURS

SUB-AREA RUNOFF COMPUTATION

MACOBY CREEK INFLOW

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
MCI	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	17.93	0.00	95.00	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	23.00	90.00	99.00	109.00	122.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .866

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 6.27 CP= .63 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 34 END-OF-PERIOD ORDINATES, LAG= 6.25 HOURS, CP= .63 VOL= 1.00

67.	247.	490.	756.	988.	1131.	1171.	1080.	915.	766.
642.	538.	450.	377.	316.	265.	222.	186.	156.	130.
109.	91.	77.	64.	54.	45.	38.	32.	26.	22.
19.	16.	13.	11.						

0 END-OF-PERIOD FLOW

NO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	NO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	24.29	21.79	2.51	260879.
										(617.)(553.)(64.)(7387.27)			

HYDROGRAPH ROUTING

KNIGHT DAM OUTFLOW HYDROGRAPH

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
KNOUT	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-213.	-1

STAGE	213.00	214.00	215.00	216.00	217.00	218.00	220.00	222.00	225.00
FLOW	0.00	1369.00	4059.00	7712.00	12234.00	17648.00	30449.00	46162.00	71753.00
SURFACE AREA=	0.	7.	19.	34.	42.	78.	85.		
CAPACITY=	0.	4.	66.	170.	361.	479.	886.		
ELEVATION=	202.	204.	209.	213.	218.	220.	225.		

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
213.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
220.0	0.0	0.0	0.

CREST LENGTH	100.	150.	160.
AT OR BELOW ELEVATION	220.0	220.7	225.0

PEAK OUTFLOW IS 25745. AT TIME 50.00 HOURS

PEAK OUTFLOW IS 32586. AT TIME 50.00 HOURS

PEAK OUTFLOW IS 68139. AT TIME 49.00 HOURS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .40	RATIO 2 .50	RATIO 3 1.00	
HYDROGRAPH AT	GLIN	71.00 (183.89)	1	22229. (629.47)(	27787. 786.83)(	55573. 1573.67)(	Green Lane Dam
ROUTED TO	GLO	71.00 (183.89)	1	20205. (572.14)(	25547. 723.41)(	52698. 1492.25)(	
HYDROGRAPH AT	IN	5.62 (14.56)	1	3529. (99.93)(	4411. 124.92)(	8823. 249.84)(	Deep Creek Dam
ROUTED TO	OUT	5.62 (14.56)	1	3484. (98.66)(	4343. 122.99)(	8714. 246.75)(	
HYDROGRAPH AT	MCJ	17.93 (46.44)	1	7871. (222.89)(	9839. 278.61)(	19678. 557.22)(	Macoby Creek
3 COMBINED	KIN	94.55 (244.88)	1	25774. (729.85)(	32614. 923.52)(	68125. 1929.08)(	Knight Dam
ROUTED TO	KNOUT	94.55 (244.88)	1	25745. (729.03)(	32586. 922.73)(	68139. 1929.49)(	

SUMMARY OF DAM SAFETY ANALYSIS

Green Lane Dam

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	286.00	286.00	297.00
STORAGE	13398.	13398.	25114.
OUTFLOW	0.	0.	60323.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.40	291.65	0.00	18870.	20205.	0.00	51.00	0.00
.50	292.53	0.00	19890.	25547.	0.00	51.00	0.00
1.00	296.14	0.00	24107.	52698.	0.00	50.00	0.00

SUMMARY OF DAM SAFETY ANALYSIS

Deep Creek Dam

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	224.50	224.50	228.00
STORAGE	141.	141.	250.
OUTFLOW	0.	0.	2136.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.40	229.13	1.13	294.	3484.	5.00	44.00	0.00
.50	229.59	1.59	314.	4343.	7.00	44.00	0.00
1.00	230.74	2.74	368.	8714.	11.00	43.00	0.00

SUMMARY OF DAM SAFETY ANALYSIS

Knight Dam

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	213.00	213.00	220.00
STORAGE	170.	170.	479.
OUTFLOW	0.	0.	30449.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.40	219.27	0.00	427.	25745.	0.00	50.00	0.00
.50	220.27	.27	500.	32586.	5.00	50.00	0.00
1.00	224.13	4.13	813.	68139.	17.00	49.00	0.00

SUMMARY OF DAM SAFETY ANALYSIS
GREEN LANE DAM

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	286.00	286.00	297.00
STORAGE	13398.	13398.	25114.
OUTFLOW	0.	0.	60323.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.40	291.65	0.00	18870.	29205.	0.00	51.00	0.00
.50	292.53	0.00	19890.	35547.	0.00	51.00	0.00
1.00	296.14	0.00	24107.	52698.	0.00	50.00	0.00

SUMMARY OF DAM SAFETY ANALYSIS
DEEP CREEK DAM- Failure Assumed
Bottom elevation of Breach 213

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	224.50	224.50	228.00
STORAGE	141.	141.	250.
OUTFLOW	0.	0.	2136.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.40	229.13	1.13	294.	3484.	5.00	44.00	0.00
.50	229.58	1.58	314.	9939.	3.36	43.50	43.00
1.00	229.93	1.93	329.	11793.	2.45	41.50	41.00

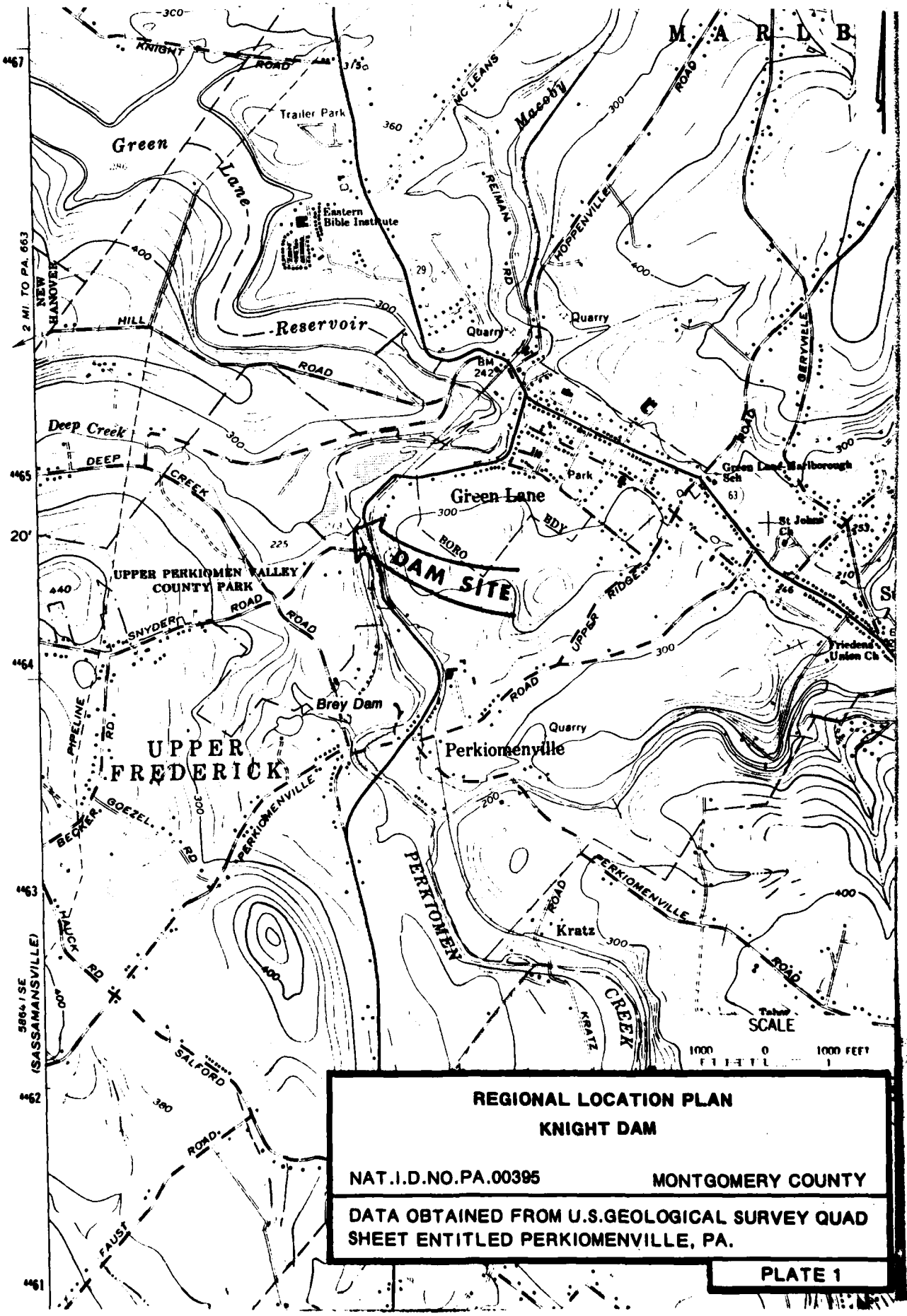
SUMMARY OF DAM SAFETY ANALYSIS
KNIGHT DAM

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	213.00	213.00	220.00
STORAGE	170.	170.	479.
OUTFLOW	0.	0.	30449.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.40	219.27	0.00	427.	25745.	0.00	50.00	0.00
.50	220.25	.25	499.	32483.	5.00	49.00	0.00
1.00	224.12	4.12	813.	68066.	17.00	49.00	0.00

APPENDIX

E



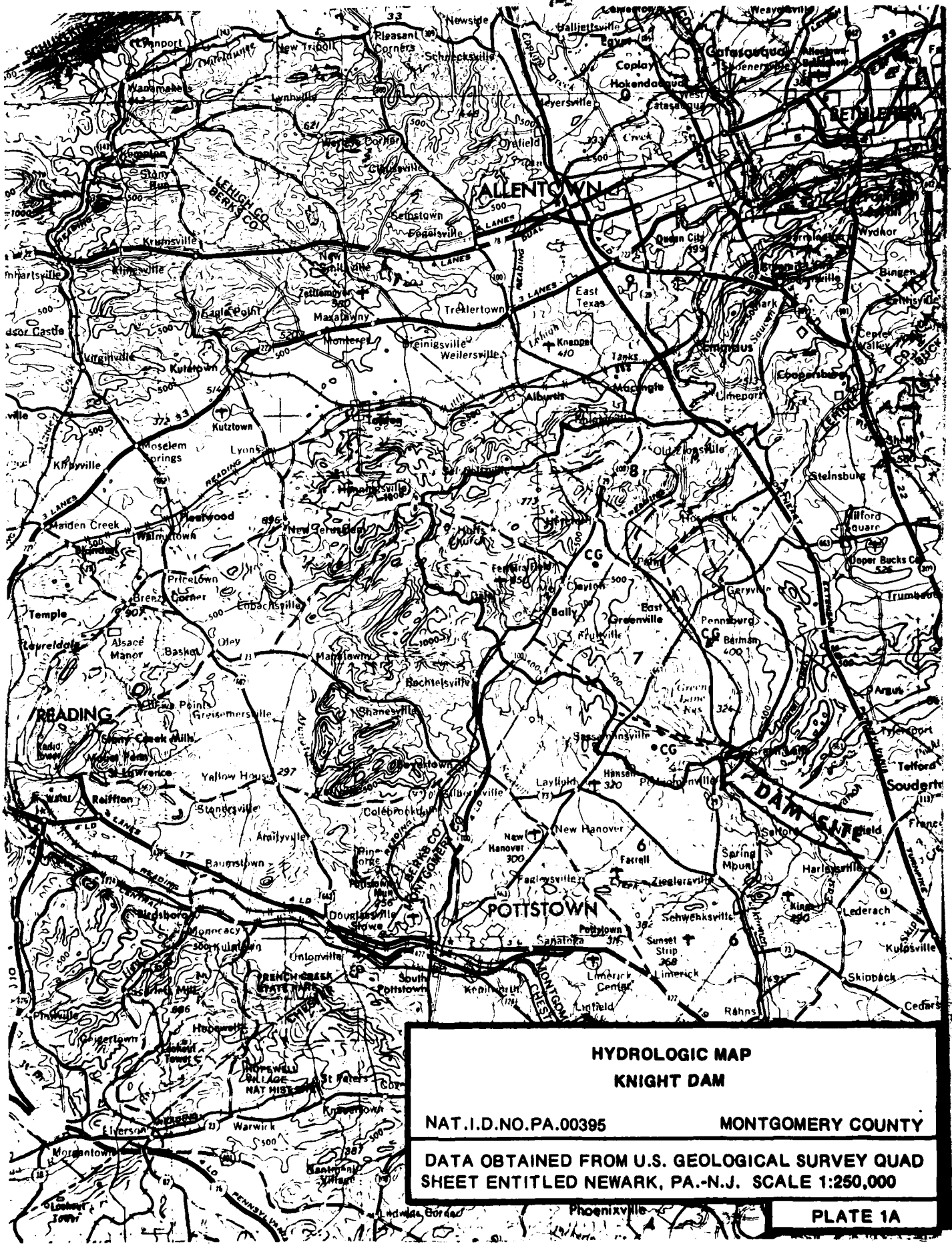
REGIONAL LOCATION PLAN

KNIGHT DAM

NAT.I.D.NO.PA.00395 MONTGOMERY COUNTY

DATA OBTAINED FROM U.S.GEOLOGICAL SURVEY QUAD SHEET ENTITLED PERKIOMENVILLE, PA.

PLATE 1



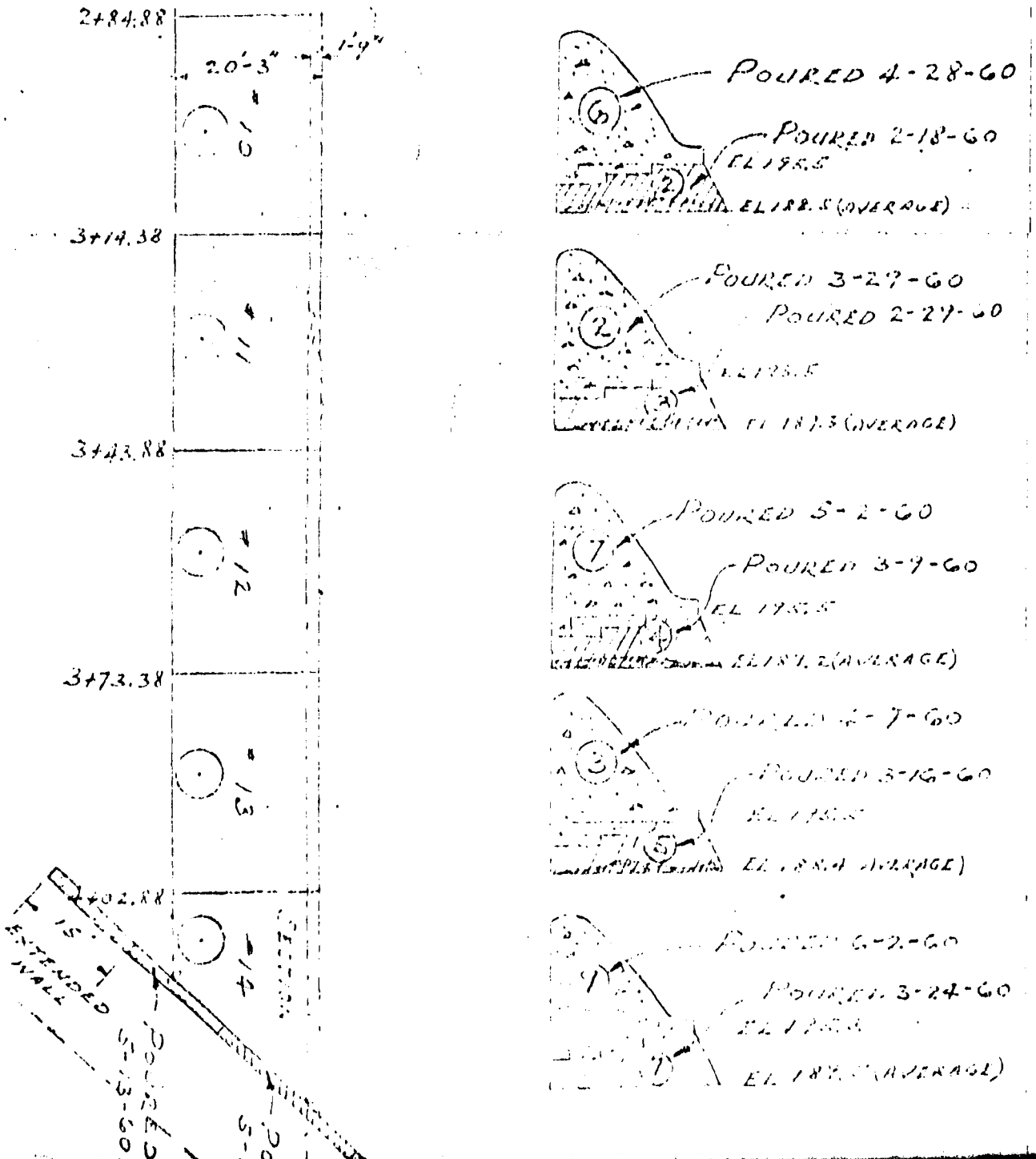
HYDROLOGIC MAP

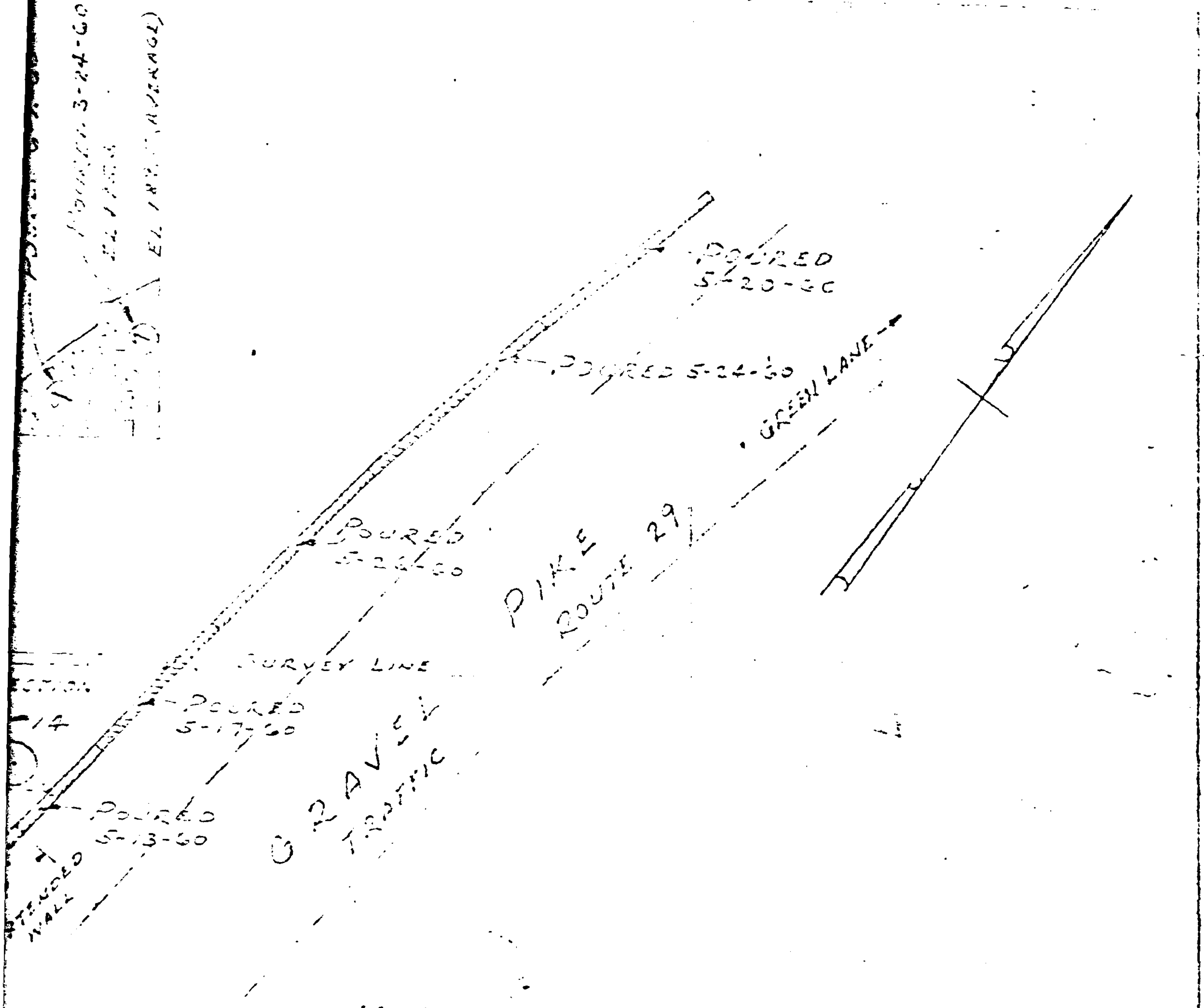
KNIGHT DAM

NAT.I.D.NO.PA.00395 MONTGOMERY COUNTY

DATA OBTAINED FROM U.S. GEOLOGICAL SURVEY QUAD SHEET ENTITLED NEWARK, PA.-N.J. SCALE 1:250,000

PLATE 1A

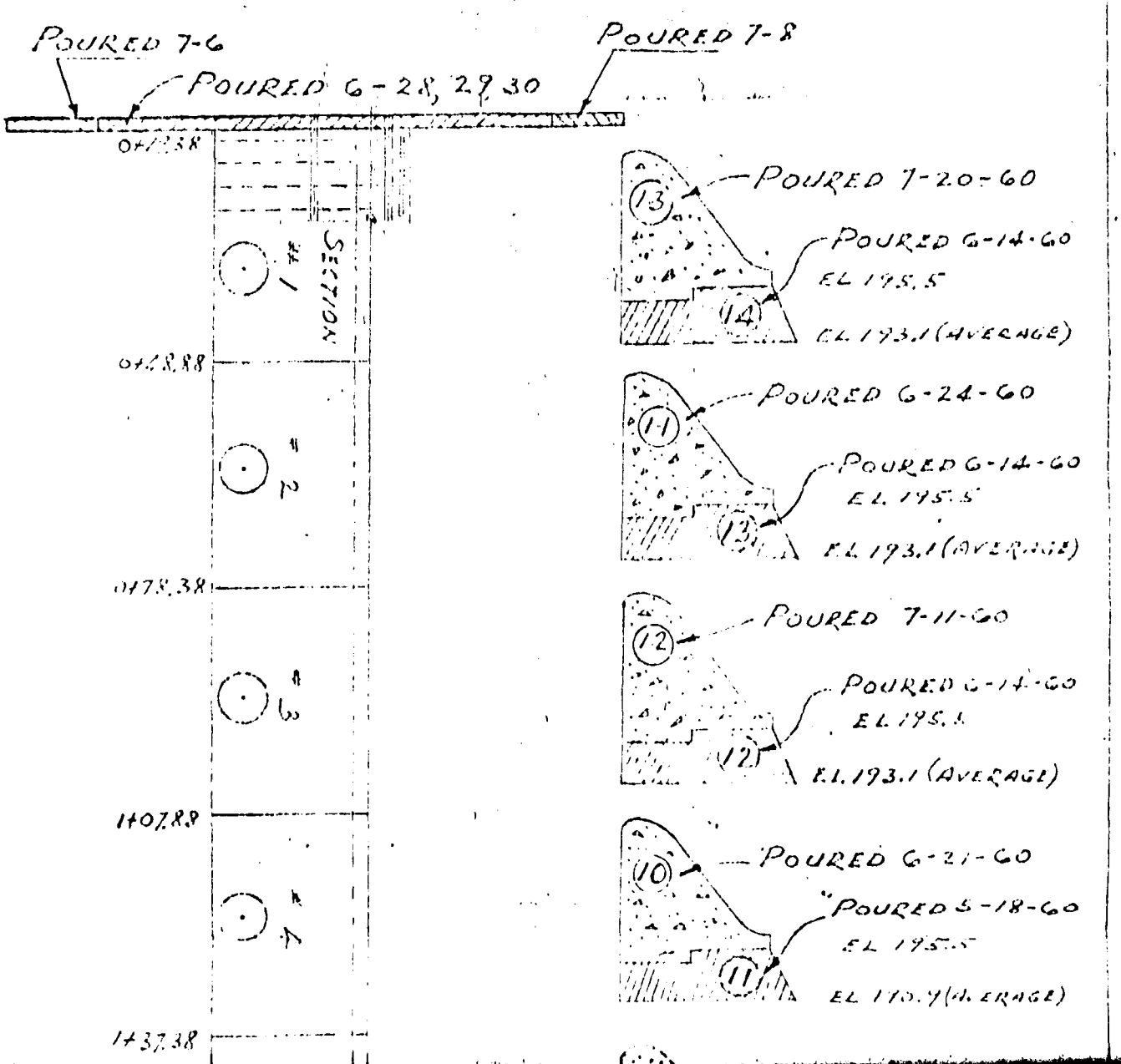

2+84.88
2'-3"
1'-9"
3+14.38
3+43.88
3+73.38
4+02.88
15" EXTENDED WALL
POURED 4-28-60
POURED 2-18-60
EL 188.5
EL 188.5 (AVERAGE)
POURED 3-27-60
POURED 2-27-60
EL 188.5
EL 188.5 (AVERAGE)
POURED 3-7-60
EL 188.5
EL 188.2 (AVERAGE)
POURED 3-16-60
EL 188.5
POURED 3-24-60
EL 188.5



KNIGHT DAM - UPPER PERKIOMEN VALLEY PARK
MONTGOMERY COUNTY - PA.

2

PLATE 2A


POURED 7-6
POURED 6-28, 29, 30
POURED 7-8
0+12.38
0+28.88
0+78.38
1+07.88
1+37.38
SECTION
#1
#2
#3
#4
POURED 7-20-60
POURED 6-14-60
EL 195.5'
EL 193.1 (AVERAGE)
13
14
POURED 6-24-60
POURED 6-14-60
EL 195.5'
EL 193.1 (AVERAGE)
11
13
POURED 7-11-60
POURED 6-14-60
EL 195.5
EL 193.1 (AVERAGE)
12
12
POURED 6-21-60
POURED 5-18-60
EL 195.5'
EL 190.9 (AVERAGE)
10
11
NOTE: NUMBERS IN CIRCLES REFER TO SEQUENCE OF POURING

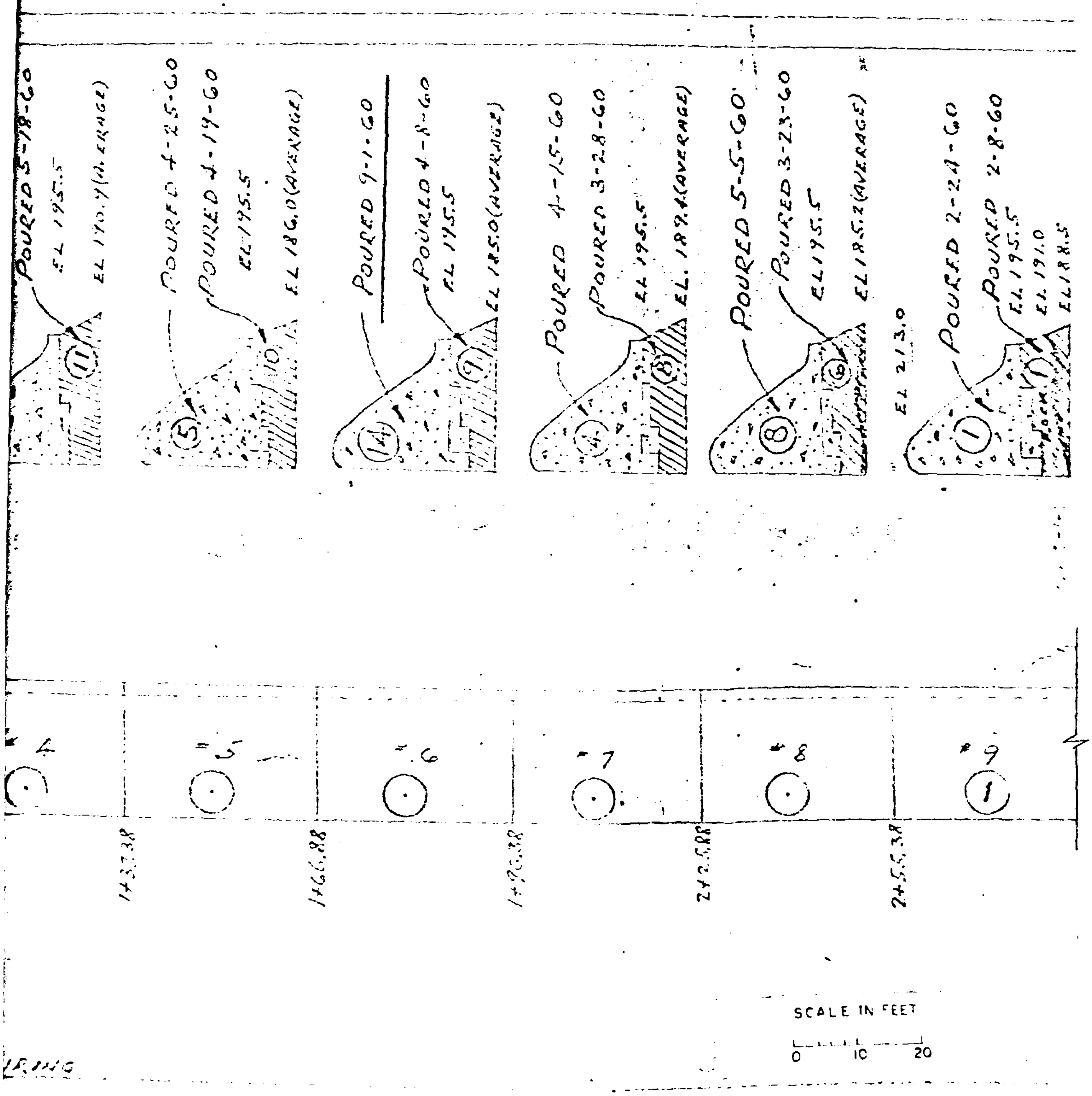
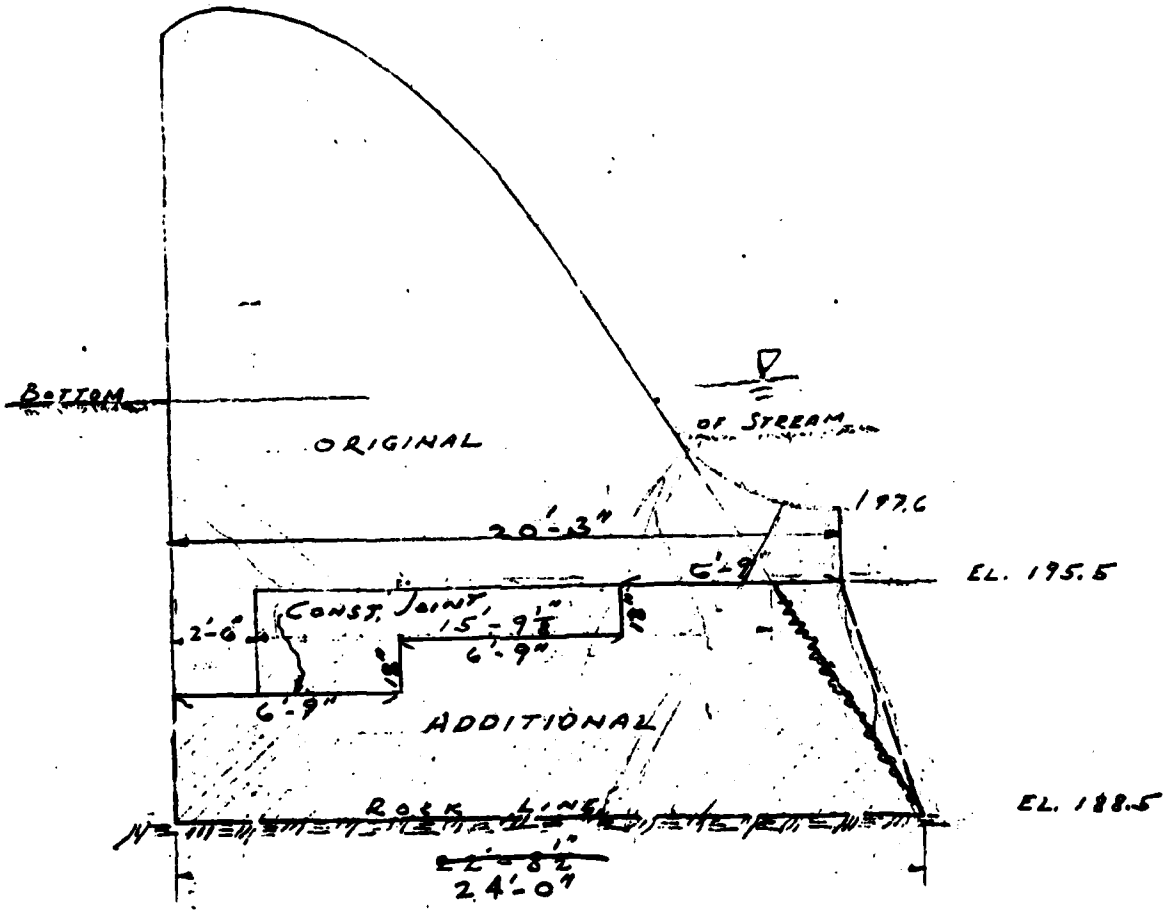
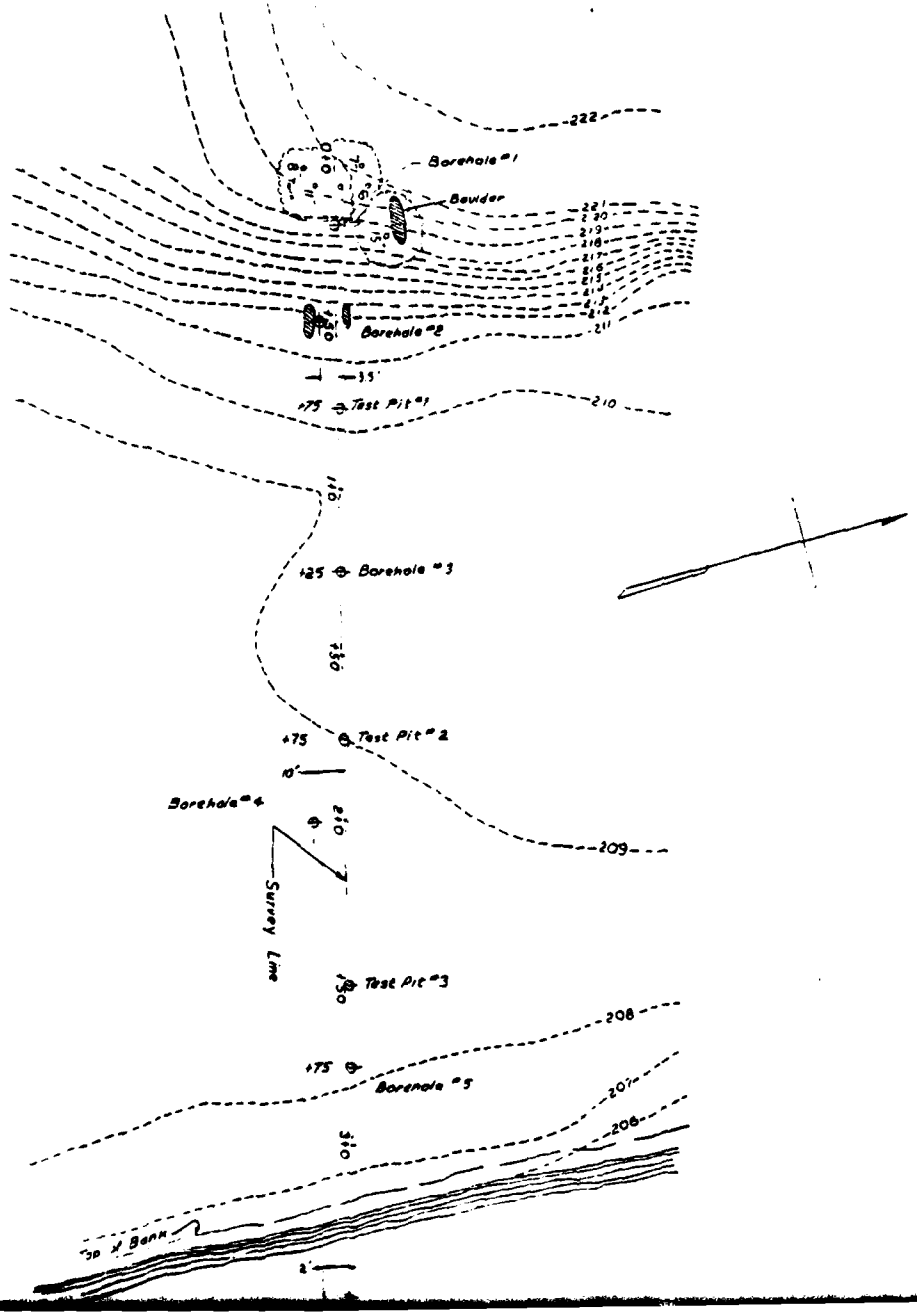

POURED 4-25-60
POURED 4-14-60
EL 195.5
EL 186.0 (AVERAGE)
POURED 9-1-60
POURED 4-8-60
EL 195.5
EL 185.0 (AVERAGE)
POURED 4-15-60
POURED 3-28-60
EL 195.5
EL. 189.4 (AVERAGE)
POURED 5-5-60
POURED 3-23-60
EL 195.5
EL 185.2 (AVERAGE)
EL 213.0
POURED 2-24-60
POURED 2-8-60
EL 195.5
EL 191.0
EL 188.5
ROCK
#4
#5
#6
#7
#8
#9
1+37.38
1+66.88
2+25.88
2+55.38
SCALE IN FEET
0
10
20

PLATE 2B



KNIGHT DAM
SPILLWAY SECTION
STA. 2+00 TO STA 2+40
SCALE ½"=1'-0"

PLATE 3


222
Borehole #1
Boulder
221
220
219
218
217
216
215
214
213
212
211
Borehole #2
35'
+75
Test Pit #1
210
110'
+25
Borehole #3
130'
+75
Test Pit #2
10'
Borehole #4
210'
209
Survey Line
Test Pit #3
208
+75
Borehole #5
207
206
310'
30° X Bank
2'

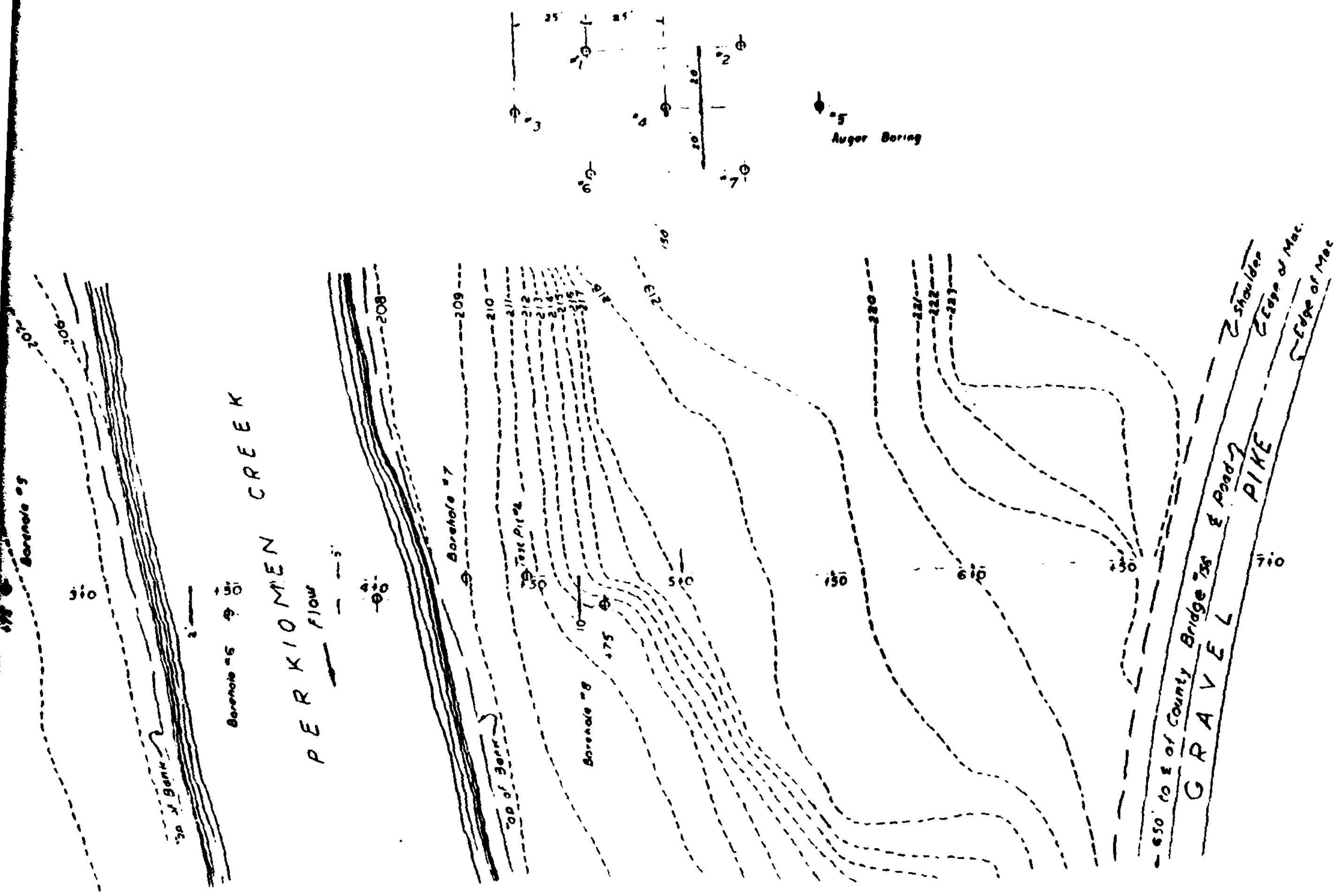
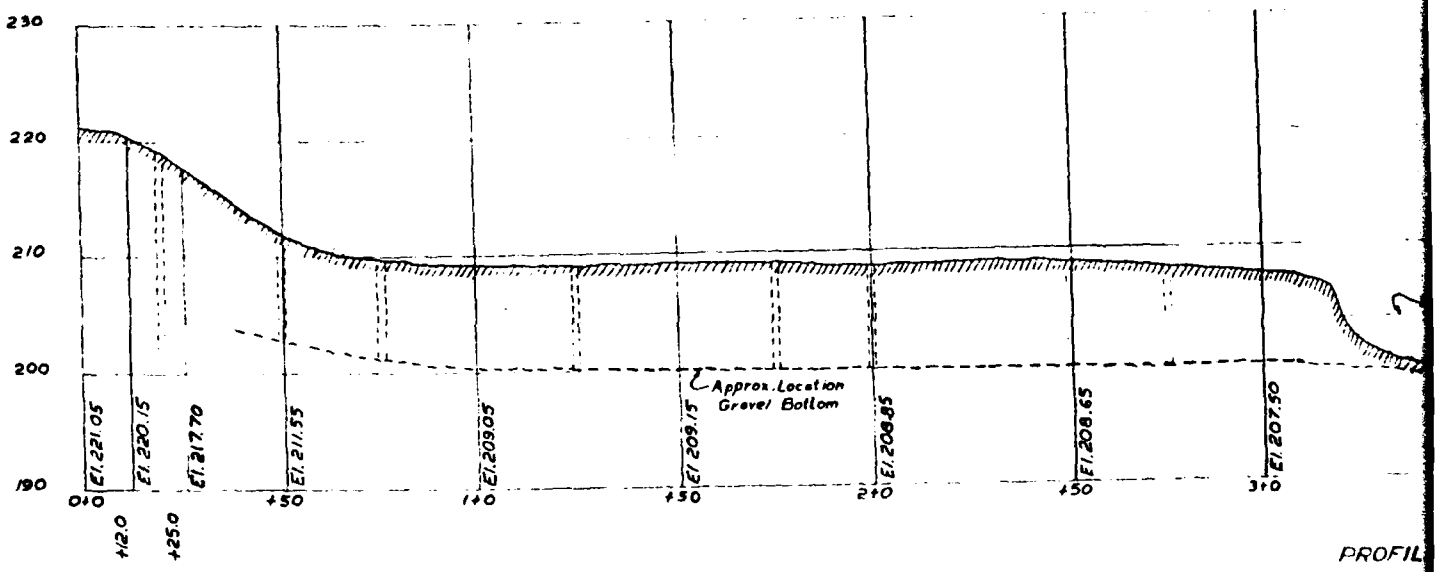
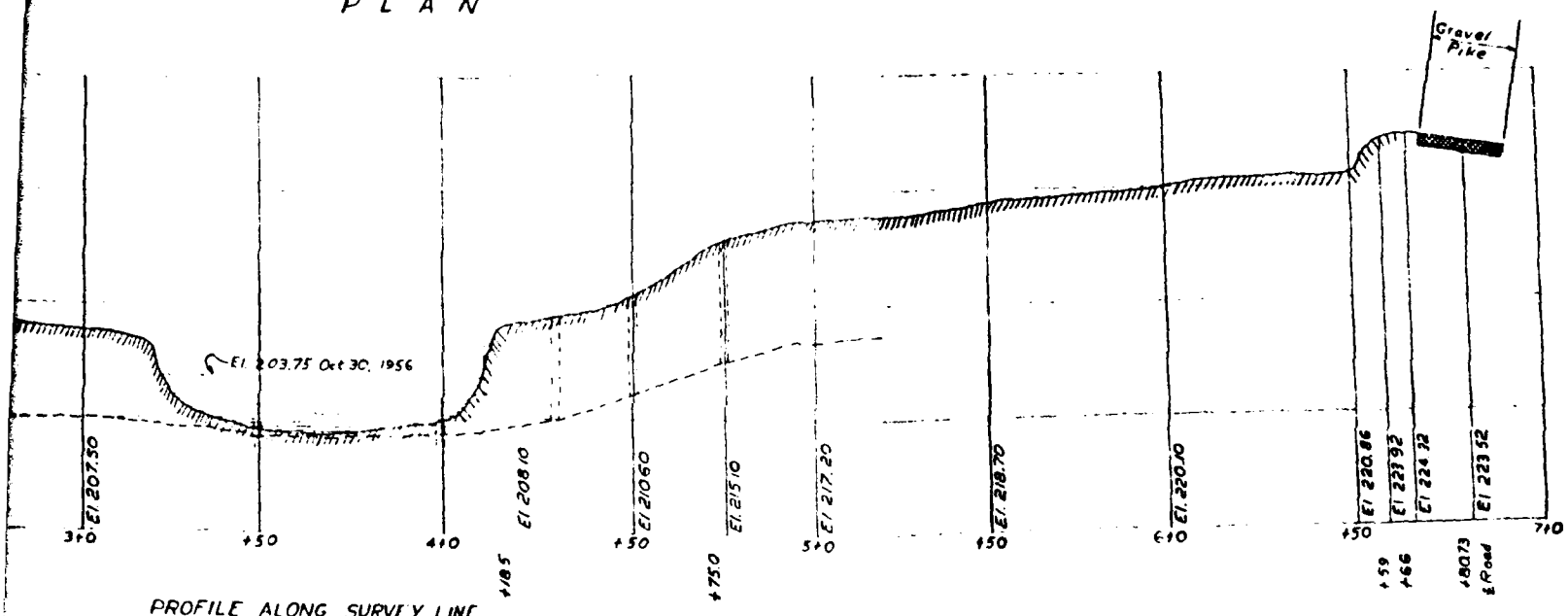

Auger Boring
PERKIOMEN CREEK
Flow
Borehole #5
Borehole #6
Borehole #7
Borehole #8
GRAVEL PIKE
Shoulder
Edge of Mac.
Edge of Mac.
Toe of Bank
Top of Bank
650' to ℄ of County Bridge #56 ℄ Road
310
410
510
610
710

PLATE 4


230
220
210
200
190
0+0
+12.0
+25.0
+50
1+0
+50
2+0
+50
3+0
El. 221.05
El. 220.15
El. 217.70
El. 211.55
El. 209.05
El. 209.15
El. 208.85
El. 208.65
El. 207.50
℄ Approx. Location Gravel Bottom

PROFIL

PLAN



PROFILE ALONG SURVEY LINE
Scale

2

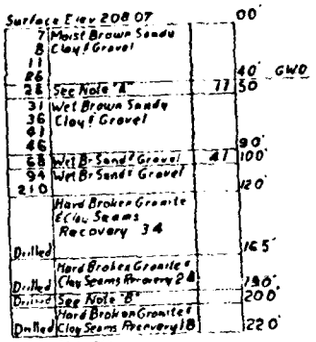
PLATE 4A

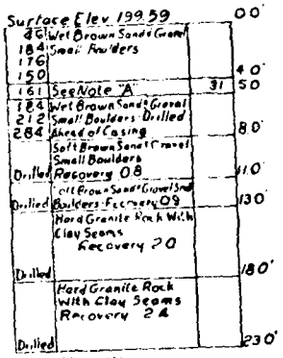
BOREHOLE N° 5
Sta - 1+75 CL

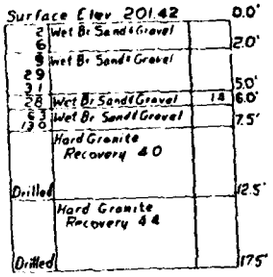
BOREHOLE N° 6
Sta 3+50 2 Rt CL

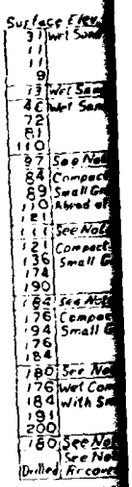
BOREHOLE N° 6A
Sta - 4+0 - 5' Rt CL

BOREHOLE N° 4
Sta- 4





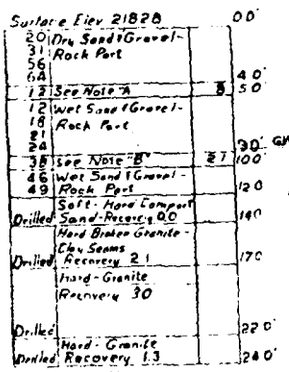


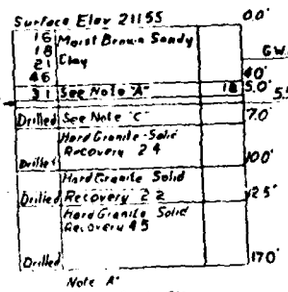


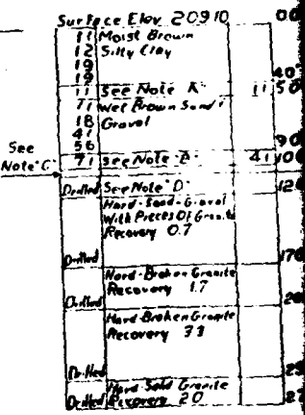
BOREHOLE N° 1
Sta 0+21.8-2' Rt CL

BOREHOLE N° 2
Sta - 0+50-35 Lt CL

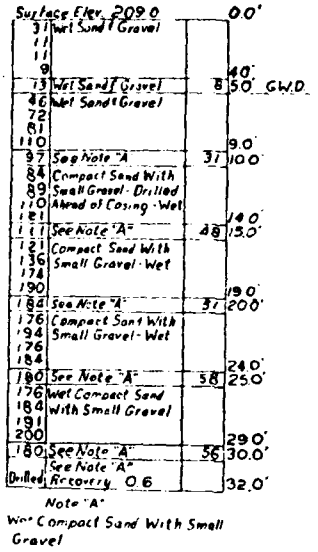
BOREHOLE N° 3
Sta- 1+25 - CL



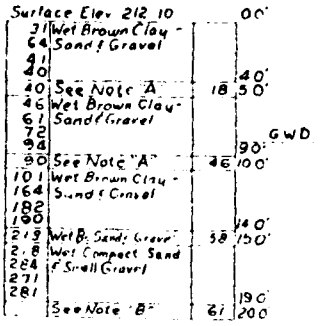




BOREHOLE N° 7
Sta- 6 +30-CL



Note "A"
Wet Compact Sand With Small Gravel



Note "A"
Wet Brown Clay - Sand & Gravel
Note "B"
Wet Compact Sand & Small Gravel

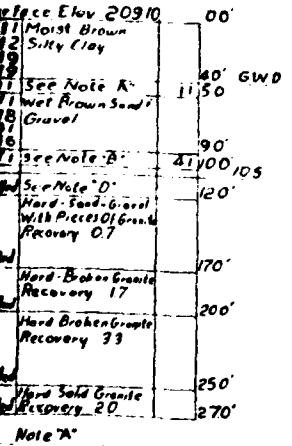
BOREHOLE N° 8
Sta- 4 + 75 - 10' Rt CL

AUGER BORING

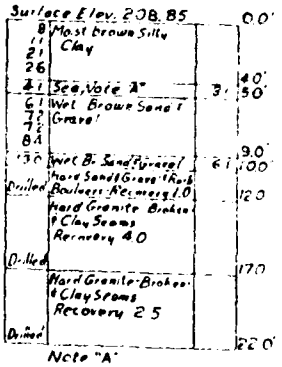
Depth	Log of Hole	Depth Drilled
	HOLE #1 Not Drilled - Boulders	
	HOLE #2	
0-2	Dry Brown Sandy Clay	2.0
2-4	Dry Brown Sandy Clay	2.0
4-5.5	Dry Brown Sandy Clay	1.5
	HOLE #3 Not Drilled - Boulders	
	HOLE #4	
0-2	Dry Light Brown Sandy Clay	2.0
2-3	Dry Light Brown Sandy Clay	1.0
	HOLE #5	
0-2	Dry Light Brown Sandy Clay	2.0
2-4	Dry Light Brown Sandy Clay	2.0
4-6	Dry Light Brown Sandy Clay & Small Gravel	
	HOLE #6	
0-2	Dry Light Brown Sandy Clay	2.0
	HOLE #7	
0-2	Dry Light Brown Sandy Clay	2.0
2-4	Dry Light Brown Sandy Clay	2.0
4-6	Dry Light Brown Sandy Clay	2.0
	HOLE #8	
0-2	Dry Light Brown Sandy Clay	2.0
2-4	Dry Light Brown Sandy Clay	2.0
4-5.5	Dry Light Brown Sandy Clay	1.5

BOREHOLE N°3
Sta- 1 + 25 - CL

BOREHOLE N° 4
Sta- 2 + 0 - 10' Rt CL



Note "A"
Brown Sand & Gravel - Change at 4.5'
Note "B"
Brown Sand & Gravel
Note "C"
Wet Brown Sand & Gravel



Note "A"
Wet Brown Sand & Gravel Change at 4.5'

TEST PITS

Depth	Log of Hole	Depth Drilled
	TEST PIT #1 - Sta. 0+87 - CL	
0 - 5	Brown Silty Clay	5.0
5 - 7.5	Grey Clay - Sand & Small Gravel	2.5
	Water Seepage in Bottom of Hole - 1 Block Sample	
	TEST PIT #2 - Sta. 1+75 - CL	
0 - 4	Brown Silty Clay	4.0
4 - 6	Brown Sand & Gravel	2.0
	No Sample - Hole Stopped by Inspector Because of too Much Gravel & Water to get Block Sample	
	TEST PIT #3 - Sta 2+60 - CL	
0 - 2	Brown Silty Clay	2.0
2 - 6.5	Brown Sand & Gravel	4.5
	No Sample - Hole Stopped by Inspector Because of too Much Gravel & Water to get Block Sample	
	TEST PIT # 4 - Sta 4+50 - CL	
0 - 7.6	Brown Sand & Gravel - Trace of Clay	7.6
	Water Seepage in Bottom of Hole - 1 Block Sample	

2

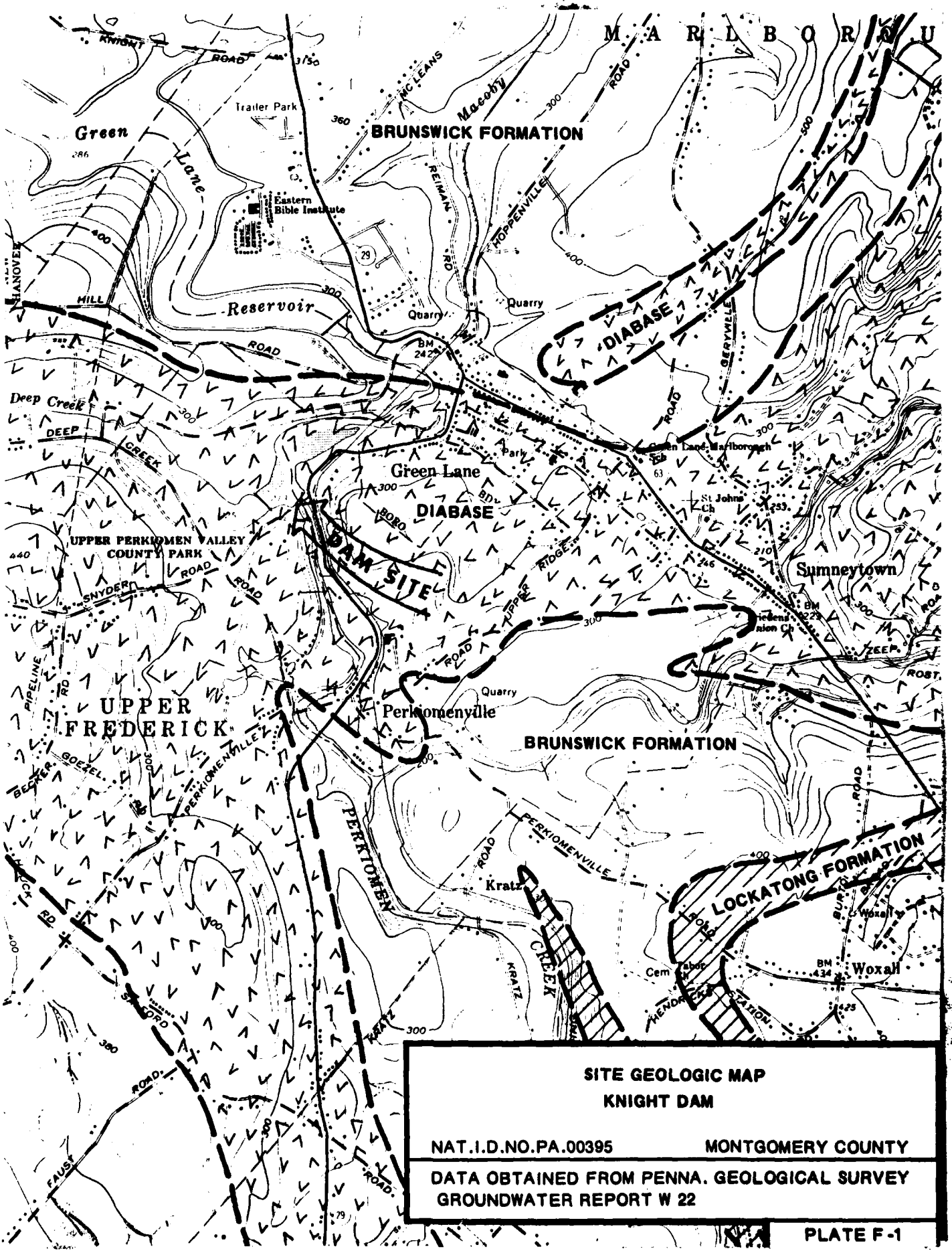
PLATE 4B

APPENDIX

F

SITE GEOLOGY
KNIGHT DAM

Knight Dam is located in the Triassic Lowland Section of the Piedmont Physiographic Province. As shown in Plate F-1, the dam is underlain by diabase bedrock of Triassic age which has intruded the Brunswick and Lockatong shale formations. The surrounding region has experienced folding resulting in broad west-northwest trending anticlines and synclines. The dam is situated within an anticline or upfold. Rock jointing observed in bedrock exposures above the right abutment area strike north-northeast and west-northwest having dips generally greater than 70 degrees. The dense diabase bedrock occurs at relatively shallow depths as indicated by the spheroidal boulders common in the area and the exposures present in the Perkiomen Creek.



SITE GEOLOGIC MAP
KNIGHT DAM

NAT.I.D.NO.PA.00395 MONTGOMERY COUNTY

DATA OBTAINED FROM PENNA. GEOLOGICAL SURVEY
GROUNDWATER REPORT W 22

PLATE F-1